

1997

# Design and training for implementation of constructivist-based distance learning environments

Mary Corwin Herring  
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Design and training for implementation of constructivist-based distance learning environments

by

Mary Corwin Herring

A dissertation submitted to the graduate faculty  
in partial fulfillment of the requirements for the degree of  
DOCTOR OF PHILOSOPHY

Major: Education (Curriculum and Instructional Technology)

Major Professors: Ann Thompson and David Graf

Iowa State University

Ames, Iowa

1997

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~~For the Graduate College~~

## DEDICATION

This work is dedicated to those individuals whose support allowed me to reach my dream:

To Ron, it has always been your love, strength, and belief in me that has allowed me to succeed. I look forward to sharing the rest of our lives together.

To Mom, you have always been there for me to share both the joys and the sorrows. One of the joys of this accomplishment is being able to share it with you.

To Shelly and Bob, now your Mom will have time to invade your lives again!

To Ryan and Jordan, I can only hope that this project will contribute in some small way to your futures.

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To Charlotte, you first planted the seed, I only wish you were here to see it blossom.

To my Father, who would be proud.

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## ABSTRACT

In response to societal shifts, K-12 teachers are attempting to design responsive, effective learning environments. A body of theory titled Constructivism has become increasingly important as a foundation for the design of learning environments that prepare students for the future demands of adulthood.

When knowledge is being constructed, the tools to support that construction become important. Societal demands, new visions about learning, emerging technology, and connectivity to the information superhighway are offering educators the opportunity and the challenge to rethink and restructure the way they go about designing effective learning environments.

This project identified a design guiding framework for constructivist-based distance education and the knowledge necessary for its implementation by distance educators. The intent of the framework is to assist teachers in the creation of constructivist-based distance education learning environments and the staff development needed to support the process. The framework is the result of a Delphi consensus building procedure in which the goal of the Delphi was to identify teacher training elements used for implementation of constructivist-based distance learning environments.

The Delphi was carried out via the World Wide Web. The panel members came to moderate or high consensus that a majority (69%) of the items were important or very important for teachers to know or be able to do to implement the learning environments. While the discussion of teacher training needs for the implementation of constructivist-based distance learning environments was extensive, several threads continually reappeared.

- Learning guide or facilitator roles for teachers

- Training needs of students to carry out learning strategies
- Embedding of assessment within the learning process
- Creation and facilitation of problem-based learning
- Multiple approaches to knowledge development

The results focused on the learning process, while technology was relegated to a secondary supporting role. The findings can assist those charged with developing the training program to support the implementation of constructivist-based distance education. Finally noted was the fact that change of this magnitude will require careful and extensive staff development for those teachers expected to effectively create constructivist-based distance learning environments.

## GENERAL INTRODUCTION

### Rationale for Study

In response to a societal shift from what has been termed the industrial age to the information age, K-12 teachers are attempting to design effective learning environments in a world that has changed its focus from one supported by machines to one supported by an individual's ability to access and use information (Banathy, 1993; Toffler, 1990). In order to prepare students to be effective learners in this changed environment, educators need time, support, and training to alter their teaching practices (Joyce & Showers, 1988; Lieberman & Miller, 1991; Sparks & Hirsh, 1997). Beliefs about educational theory and practice are fundamental to the way that teachers organize and think about learning (Connelly & Clandinin, 1988). Attention to both areas facilitates their ability to change their practice (Fullan, 1991).

Learning theory supports much of the curricular and instructional decision-making that occurs in education (Fosnot, 1996). Theory can provide guidance and direction for changing practice. A body of theory titled "Constructivism" has become increasingly important as a foundation for the design of learning environments that prepare students for the future demands of adulthood. Application of constructivism to education finds students, in order to generate knowledge, engaged in tasks that allow the self-regulation of learning in an interactive setting. The focus in this type of learning environment (i.e., an authentic environment) is on the construction of personal knowledge in a context similar to that in which the knowledge will be applied (Savery & Duffy, 1996).

When knowledge is being constructed, the tools to support that construction become important. The advent of increased access to world-linking technology offers teachers expanding technological tools and rich opportunities for the design of learning environments. Increasingly powerful technology has created the potential of redefining how we communicate and educate through the use of new types of messages and experiences. Societal demands, new



visions about learning, emerging technology, and connectivity to the Internet are offering educators the opportunity and the challenge to rethink and restructure the way they go about designing effective learning environments.

Though there has been much discussion about the topic of constructivism and the topic of distance education, little has been discussed about combining the two. Even less has been discussed about the knowledge teachers will need to design and implement constructivist-based learning environments. This study brought together a very knowledgeable cadre of individuals in constructivism and technologically mediated learning from across the United States for the purpose of identifying the elements a teacher must have to responsively create, facilitate, and evaluate constructivist-based distance learning environments.

Using the Delphi consensus building technique, a nationally recognized panel identified instructional design components or experiences as well as the elements needed for their implementation and use by teachers. To provide a more authentic context for the study, the entire project was carried out via the Internet, using email for communication and the World Wide Web (WWW) for the Delphi process. A number of Delphi studies have been carried out through the use of email, but a review of literature could find no Delphi studies that used the WWW as the primary vehicle for the process. The underlying premise of this study was to address the needs of public school teachers who are charged with implementing a multitude of calls for change within the distance learning environment.

#### Dissertation Organization

This dissertation is written in the alternative format approved at Iowa State University. It consists of three research papers, the first serving as the introduction and first chapter for a proposed book, and the next two as submissions to scholarly journals. The first paper, "Constructivism in Cyberspace: Preparing Teachers for Distance Education In the Twenty-first Century," examines the impact of societal changes on education and the combination of constructivism and distance education. The preface describes the intent and chapters of the

book. The chapters are based on five design-guiding principles that also serve as the framework for the Delphi study procedure described in article two. Particular attention is paid to defining two constructivist schools of thought, cognitive constructivism and sociocultural constructivism. There is an extensive examination of the instructional design process. In particular, the parameters of constructivist learning environment design, which can assist K-12 teachers as they move from traditional instructional design methods to constructivist-based design methods are defined. The traditional tenets of replicability, reliability, communication, and control are replaced with constructivist tenets of collaboration, learner control, generativity, reflexivity, personal relevance, and social negotiation of knowledge (Lebow, 1993). In addition, the role of technology to support changes in the design of technologically mediated learning environments is examined.

The second paper, "Development of Constructivist-based Distance Learning Environments: A Knowledge Base for Teachers," addresses the needs of teachers who are expected to design and implement curriculum in a constructivist-based distance learning environment. A core of learning environment design components or experiences and teacher training elements necessary for their implementation are identified and discussed. This core of components, experiences, and elements was the result of an interaction among the Delphi consensus building method, a cadre of nationally recognized individuals in the areas of constructivism and technologically mediated education, and a framework of five constructivist-based design-guiding principles.

The third paper, "Implementing Constructivist-Based Distance Education: More than a Workshop," uses data collected from the Delphi study to provide staff developers with a needed knowledge framework for training teachers in the development of constructivist-based distance learning environments. The framework includes the areas of: (a) *Knowing How We Know*; (b) *Learning, From the Student's Vantage Point*; (c) *Authentic Learning*; (d) *Concept Exploration*, and (e) *Responsive Assessment*. This information is intended to be adapted for

those individuals participating in training. Since the training will be as varied as the needs of participants, the information will be presented as a body of knowledge rather than a step-by-step process. It will be up to the staff developer to assess the needs of the participants and then target the training specifically.

The strength of this research lies in its attention to areas that have seldom been discussed: the integration of constructivism and distance education and the knowledge that teachers require for design and implementation. The first paper is unique in that it draws from two areas that heretofore have had little integration. New forms of technology are opening opportunities to teachers and students for new configurations of collaboration and knowledge generation. Constructivism offers theoretical guidance for teachers who are struggling with the plethora of information for which their students have access. This paper also provides the instructional designer with information on the change from traditional forms of instructional design to one grounded in constructivism. The Delphi method, as discussed in the second paper, provides comprehensive data about designing learning environments that will be responsive to the changing needs of students. Using a grounded theory of analysis, responses from 15 panel members were analyzed, categorized, and turned into a hierarchical, Likert scale instrument. The purpose was to discover the items on which the panel members would come to consensus as important for teachers to know or be able to do. Results provide a solid body of knowledge for teachers and staff developers to use in preparing teachers to function effectively within emerging learning environments.

Those charged with rethinking and restructuring the way educators design and implement distance education will find guidance in the third paper, "Implementing Constructivist-Based Distance Education: More than a Workshop." This article presents a design-guiding framework for constructivist-based distance learning environments as well as the knowledge necessary for its implementation by distance educators. A review of an article on constructivism and computer-mediated communication in distance education reaffirmed the

importance of this study. Examination of the Delphi study data found three training threads that were consistent with the authors' conclusions. Missing from their discussion, however, were two of this Delphi study's findings, the role of the teacher in the learning environments and the training needs of students to execute learning strategies, pointing to the importance of this study's findings. Finally, a discussion of future directions for effective staff development is presented.

References cited and appendices in this dissertation are listed at the end of each paper in which they are referenced. References cited in the general introduction and general conclusion sections are also listed at the end of the section in which they appear.

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## CONSTRUCTIVISM IN CYBERSPACE:

### PREPARING TEACHERS FOR DISTANCE EDUCATION IN THE 21ST CENTURY

The preface and first chapter of a book, to be used to support the training of K-12 teachers in the design of constructivist-based distance learning environments.

Mary Herring

#### Preface

"Constructivism in Cyberspace: Preparing Teachers for Distance Education in the 21st Century" is aimed at any individuals who are working with public school teachers in the development of constructivist-based distance learning environments. Constructivism is a relatively new body of learning theory that acknowledges the effect an individual's prior knowledge and perceptions has on the creation of new knowledge. Cyberspace is a virtual teleworld created through the use of telecommunications (see Glossary) via the Internet (Tiffin & Rajasingham, 1995). For the purposes of this book, cyberspace is a place where technology joins together people, resources, and an educational entity, electronically, in various settings to create a synchronous or asynchronous interactive distant learning environment. Learning environments in cyberspace can be created through the use of technologies such as computers linked to the Internet and educational networks linking students through the use of fiber optics or videoconferencing equipment. The increasing accessibility of new, more powerful technologies for educators' use offers potentially revolutionary possibilities for teaching and learning (Randall, 1992).

As the definition of classroom changes, methods to create, implement, and assess the learning also need to be reexamined. Classrooms may no longer be defined by four walls; instead, they can become places with no walls which provide the learners with global accessibility to people, places, and information. The intent of this book is to provide teachers,

and those charged with supporting teachers, assistance in the creation of effective learning environments in cyberspace.

In cyberspace, a learner can be linked to other people, technology, and information sources in a setting that situates the learner within the learning environment rather than viewing it externally. The technology becomes an integral part of the environment due to its capacity to adapt its performance in response to users' inputs. Cybernetics, programs incorporating human and machine intelligence that function in cyberspace, offer the learner a creative medium that has a "better chance of being open enough to offer something to everyone" (Papert, 1992, p. 183) rather than programs which require the learner to function within the parameters programmed by an external source.

Constructivism is a body of learning theory that reflects a view of the learner as a lamp to be lit as opposed to a "vessel to be filled" (Papert, 1992, p. 14). Students take responsibility for developing and following a learning path. Teachers serve as facilitators of the students' knowledge construction process. Constructivism provides a view of learning that seems to fit well with the demands of functioning in cyberspace-like settings, due to its learner centered focus. Cyberspace offers a place where the learner can choose paths of exploration and experimentation, thus it is a constantly evolving place that can be responsive to changes in the learner and in the world. The implementation of constructivist tenets offers a vehicle that travels well in the ever-changing cyberspace.

Technology is taking teachers and students outside the confines of a traditional classroom and into a world created by the paths of their search for knowledge. Distance learning environments presently offer interactivity with individuals and information resources around the world, exposing students to multiple viewpoints, better understanding of global perspectives, and varying opportunities for personal construction of knowledge.

This book is intended not as a "cookbook," but as a resource to provide guidance for the staff development and support of public school teachers as they connect new theory and

practice with emerging technology (i.e., high performance computing and communications technology that can vary instructional methods and media systematically according to the cognitive demands of learning tasks [Hooper & Hannafin, 1991]) while preparing students for future worlds. As education attempts to react to and reflect changes in the world and societal demands, teachers are expected to be the change-makers. Unfortunately, these “change-makers” are often not supported with in-depth staff development and follow-up activities, often resulting in minor tweaking of the curriculum with little impact. Successful designs for staff development require time, resources, and supporting structures (National Staff Development Council [NSDC], 1995). Educational change often falters or fails because the change is poorly resourced or resources are withdrawn once the initial flush of innovation is over (Hargreaves, 1997). All too often initial change plans are not followed with resources for implementation.

The chapters of this book provide those interested in instructional design with a framework and resources to support the creation of effective learning environments in cyberspace. The framework, consisting of five principles, was developed through a conversation between a panel of knowledgeable individuals in the areas of technologically mediated learning and instructional design (Herring, 1997). For each principle, the panel identified a series of learning environment design components or experiences and elements important for teachers to know in order to create constructivist-based distance learning environments. This book is the embodiment of the discussion and is meant to support the creation of effective learning environments in cyberspace.

Chapter one situates constructivism and distance education within the world’s changing landscape and provides a foundation for understanding the ramifications of that combination. To provide a structure for this combination, five design-guiding principles are introduced to serve as a road map for the development and implementation of constructivist-based distance learning environments. Chapters two through six each address one principle with each principle discussed in relation to its impact on teachers as they seek to design distance learning



environments. The chapters and principles are not meant to describe a step-by-step process but instead should be viewed as a whole, an overall picture of the components needed to support the design process.

Chapter two focuses on knowing how we know. Constructivists often define knowing how we know as reflexivity. Reflexivity is a metacognitive strategy; that is, the process of thinking about thinking, such as thinking about how to approach a task (Jonassen, Mayes, & McAleese, 1991). From a constructivist viewpoint, the importance of the awareness of the constructedness of knowledge and the learning that comes from having active control over that construction process is considered critical to the learning process (Knuth & Cunningham, 1993). Metacognitive knowledge includes information about ourselves as learners, the kinds of tasks we encounter, and the strategies employed to influence the outcome of the cognitive activities (Dunlap & Grabinger, 1996). This chapter includes information about methods to develop learning environments which allow student input and manipulation of learning experiences. The authors provide descriptions of the use of overt strategies for student reflexivity, such as the use of student journals to record the processes and strategies used during the learning experience or suggestions for the development of products that will reflect student knowledge. They also provides suggestions of strategies that facilitate student reflexivity such as the use of questions that encourage the learner to compare chosen strategies and to evaluate their effectiveness in the learning process.

Chapter three focuses on learning from the student's vantage point. Knowledge domains are not readily separated in the world; information may be drawn from various areas as one analyzes an issue. Learning situations should be dynamic enough to accommodate the learners' varied levels of expertise, development, and culture, thus allowing students a sense of ownership in the learning process. A central or core body of information must be defined, but the boundaries of what may be relevant must be left open with the goal being the movement of the learner into thinking as an expert might within the knowledge domain (Bednar,

Cunningham, Duffy, & Perry, 1992). This chapter, focused on student-centered learning, offers staff developers examples of design components or experiences as well as essential teacher training elements needed if the components or experiences are to be integrated into the curriculum. These types of strategies have the ability to confront the learners with situations that make inconsistencies in naive knowledge models plain and serve to challenge learners to either construct better models or at least judge the merits of alternative models (Perkins, 1991). The impact of schema the learner has available to support knowledge acquisition based on a novice to expert continuum is identified. The teacher's mindfulness of the learner's place on the continuum allows the facilitation of learning by inquiring at the "leading edge" of the learner's thinking. Also addressed are methods that use Vygotsky's Zone of Proximal Development which represent the type of learning interactions that occur between teacher and student in this process.

Chapter four focuses on authentic learning. The major goal of authentic instruction is to create environments that permit sustained exploration by students and teachers in settings that can be seen as real, enabling them to understand the approach experts take and the knowledge these experts use as tools. Students learn by doing when they work in meaningful and realistic contexts which allow them to function much as an expert in the area. In this chapter, explanations of students' projects that require the definition of problems, identification of resources, setting of priorities, and exploration of alternative solutions as they would in the real world are provided. Descriptions of the teacher's role as facilitator of learning are provided with each of the project explanations.

Chapter five focuses on concept exploration. In this chapter, the students' exploration of conceptual territories is accomplished through the social negotiation of knowledge. This process locates learning in the co-participation of knowledgeable individuals and students, where students' evaluate and expand individual understandings through the shared experiences (Cobb, 1996). Articulating one's position to another can cause the learner to recognize gaps in

understanding or form new connections between formerly disconnected knowledge. The interaction between speaker and listener facilitates this process as they attempt to reconcile differences in their perspectives, opinions, and experiences with the result being new knowledge, reorganized knowledge, or the awareness of a need for additional understanding (Edelson, Pea, & Gomez, 1996). The use of methods such as collaborative problem solving gives "rise synergistically to insights and solutions that would not come about without them" (Brown, Collins, & Duguid, 1989, p. 40). Methods that expose students to multiple perspectives and methods of problem solving are offered to assist in the creation of socially negotiated learning environments.

Chapter Six focuses on responsive assessment. This chapter presents ideas for designing multiple levels of learning, including verbal information and discrete skills as well as higher-order problem solving, cognitive strategies, and attitudes with a focus on evaluating the application and active use of knowledge. The what and how of learning are concerns of the designers of constructivist learning environments. In the K-12 arena, teachers are the primary learning environment designers. References to "designers" or "instructional designers" in this book will mean the K-12 classroom teacher. Development of strategies for responsive assessment need to emphasize learners' strengths while providing information directly to learners so that they are empowered to make their own decisions about learning goals and activity. Explanations of the use of authentic, performance, and portfolio assessment are presented to assist in the development of purposeful, dynamic assessments.

A number of books have been written about constructivism and about distance education. What makes this book unique is the combination of these two areas. This combining of constructivism and distance education will allow educators to be both reflective of visions of education and responsive to the needs of a quickly changing world. With the five design principles providing the framework, this book furnishes educators with information needed to

implement new approaches to education as they prepare their students to travel into the 21st century.

### Chapter One: A Vision of the Future

Cyberspace can be a place where students will no longer be observers of phenomena but active participants in interactive learning environments (Perelman, 1992). For example, instead of learning the parts of a heart from the outside looking in, the student, through the use of virtual reality technology, will go inside the heart and watch what occurs when adrenaline is introduced or if a valve is diseased. Such technology can “help condense mountains of boring info-bits into exquisite sandcastles of insight” (Perelman, p. 42). It was not long ago that cyberspace was a place unknown to educators. Now, the term represents a future for which educators are expected to prepare students.

This chapter is organized to help those involved in designing distance education classes reflect and respond to a changing society and changing technology. A short discussion of the impact of a changing society on education provides the backdrop for the designer. Next, an explanation of a foundation for instruction, the learning theory of constructivism, and a description of methods for theory implementation, design of learning environments, are provided. In addition, the vehicles for traveling in cyberspace, distance education technologies, are discussed. Distance education, the place where the theory and the vehicles come together, is explained. Finally, the combination of distance education and new “vehicles” for traveling in the learning landscape are explored.

### Change

The world, as we know it, is changing. In the 21st century, an educated person will need to be able to think, learn, and work in a technological environment that integrates voice, audio, and data transfer in nanoseconds. Through the use of technology, the Internet has opened the door for people to collaborate in real time even though they are miles apart. Businesses can now hold global staff meetings in a Multi-User Simulation Environment

(MUSE), a virtual environment that provides opportunities for multisite participants to take part in discussions under a veil of anonymity. On the other hand, videoconferencing is allowing co-workers from around the world to converse in virtual face-to-face discussions while they work on computer-based collaborative projects. Meanwhile, documents are being shared via worldwide electronic networks.

Society has experienced a shift in the past decade from an industrial to an information society (Reigeluth, 1994; Toffler, 1990). This shift is from an economy built on the use of machines for production to one based on ability to access and use information in a productive manner. This shift will require the development of a "population familiar with the informational infrastructure as it has been with cars, roads, highways, trains, and the transportation infrastructure" (Toffler, p. 349). Meanwhile, workplace expectations are also shifting from expectations of compliance, conformity, and compartmentalization to ones where problem-solving, diversity, and networking are valued (Reigeluth, 1996).

Unfortunately, our educational system is still grounded in the industrial age, so change to meet the demands of the knowledge-based information age economy are causing great disequilibrium within the educational community. New theories of learning and old paradigms of education appear to be on a collision course. In the United States, political leaders, employers, and the community at large are expressing an unprecedented level of concern with the state of education. A new openness to consider fundamental change and innovative approaches can be seen in the number of reform efforts that involve governors, state legislatures, and business coalitions. Educators, including teachers' associations, colleges of education, and school administrators are also involved in reform efforts. Due to the changes technology has precipitated in the workplace, the business community and the public in general are exerting pressure for comparable changes in their schools (Means et al., 1993).

In a society where much of the work is becoming computer-based, "schoolwork" is an area in which change must occur. When technological innovations (e.g., books, automobiles,

television) become a part of everyday life, their impact spreads throughout society, including education. For example, the integration of television into society has resulted “in a decline in the print culture and the rise in a visual culture” and a “lower tolerance for boredom” by students (Collins, 1991, p. 30). For the youth of today, the geography of learning is stretching far beyond the physical space of the classroom. Teachers are losing their hold on student learning as the computer keyboard dissolves the distinction between “what’s out there” and “what’s in here” (Hargreaves, 1997). Those who develop the learning environments are finding the need to develop learning contexts that respond to these changes.

As computer and electronic networks become common in the home and the classroom, teachers will need to determine ways in which technology can support learning. The business world is telling educators that people entering the workforce in the 21st century will need quite different skills than those presently needed (Hargreaves, 1997; Schlechy, 1991). Consequently, teachers and administrators are struggling to deal with calls for reform as well as new methods of instruction and increased technological power.

#### Potential for Change

Radio in the 1930s, television in the 1960s, and computers in the 1980s are broad examples of technologies that were predicted to change the classroom but did not. Micro-demonstrations of this phenomenon are found in studies of specific sites where an investment in technology incorporated into school settings with the idea of changing the way education was carried out, showed little or no change (Oakes & Schneider, 1984). However, as societies move into the information age, an environment ripe for change has been created. The types of skills necessary for professional success have changed from skills needed to produce manufactured items to skills necessary for dealing with vast quantities of information. These necessary skills are based on theories of learning that have shifted from teacher-centered delivery of information to student-centered construction of knowledge. The tools used to support the learning of those skills are also changing. Computers, which were once seen as a

discipline within the school curriculum, are now becoming the tools to assist students and teachers accomplish tasks (Simonson & Thompson, 1994). Concepts of "class" and "classroom" are also changing. The growth of fiber optic networks is reconfiguring classrooms into powerful digital environments capable of transferring video, audio, and data simultaneously. The confluence of these changes opens vast new landscapes for learning. Just as traditional landscapes change for the traveler so, too, does the learning landscape change as new configurations of technology and education open opportunities for changes in the configuration of the learning environment.

### Configurations of Change

Hundreds of Internet educational sites offer students and teachers opportunities for collaboration and exchange of information with peers and experts from around the world. To take advantage of these opportunities and to be responsive to students' future needs, many states are developing educational networks to link all levels of education. The state of Iowa plans to have 625 classrooms on their state owned fiber-optic network, the Iowa Communications Network, by the year 2000 (Iowa Educational Technology Training Institute, 1996). Estimates are that United States schools average one computer for every ten students -- about 4.5 million computers -- while access to some form of computer network is found in thirty-five percent of schools (Quality Education Data, 1996). The Internet, an interconnected collection of more than 80,000 computers around the world (Harris, 1995), and its hypertext child, the World Wide Web, continue to see incredible growth. By the year 2000, it is predicted there will be 3-5 million U.S. K-12 students who use Internetworked resources and tools (Itzkan, 1994 -1995).

The integration of the technological infrastructure and education is allowing new configurations of the structure of a "classroom" to appear on the distance educational horizon. The term "distance education" refers to teaching and learning situations in which all or some of the students and instructor are geographically separated, and therefore, rely on electronic

devices and other support material for creation of the learning environment (Portway & Lane, 1994).

Classrooms can now be visually and cognitively extended via some form of teleconferencing. It has been suggested that these new capabilities, along with new methods of instruction, have opened classrooms to a new type of learning called hyperlearning (Perelman, 1992). Hyperlearning is

not a single device or process, but a universe of new technologies that both possess and enhance intelligence. The hyper in hyperlearning [HL] refers not merely to the extraordinary speed and scope of new information technology, but to an unprecedented degree of connectedness of knowledge, experience, media, and brains--both human and nonhuman. The learning in HL refers most literally to the transformation of knowledge and behavior through experience . . . (p.23).

The concept of hyperlearning is just one example of the impact of potential change on education. The linking of multiple classrooms for interactive learning sessions, the availability of audio and video conferencing via personal computers, the increased access to volumes of information, and the suggestions for changing the way learning is carried out have all contributed to a changing view of classroom and instruction (Walsh & Reese, 1995).

There is little doubt that technology will influence the configurations that allow people to go about learning. Internet, electronic mail, satellite, and interactive video and audio connections have created untold opportunities for academic enrichment and have transformed numerous classrooms into interactive laboratories allowing access to almost limitless resources, people, and timely information. If education is to change to reflect evolving societal needs and incorporate technology, the needs of those expected to implement the change, the teachers, must be addressed.



### Focus of Change

In the past 10 years some of the major points of educational interest have been the curriculum and design of learning environments and attempts to integrate emerging technology within those environments (Hannafin, 1992). Teachers and teacher education programs have traditionally focused on content knowledge. However, because of reports such as America 2000: An Education Strategy (U.S. Department of Education, 1991) and the Governors' Task Force on Education (National Governors' Association, 1990) calling for not only changes in what the schools are teaching but also in how they are teaching, a new interest in the need for change has arisen. This interest could be attributed either to the research or writing that has been done on what affects students' processing of knowledge using theories of learning such as constructivism (see, e.g., Brooks & Brooks, 1993; Fosnot, 1996; Wilson, 1996), or, to the increased access to and the changing role of technology in the classrooms. Hadley and Sheingold (1993), in their study on the integration of computers into the classroom, reported that the computer-using teachers felt significant changes were taking place as they integrated technology into the classroom. For most of the teachers, computers were not single-use machines, but rather multipurpose tools that were used in many ways. In fact, on the average, the 608 participants used between 14 and 15 different practices. The most frequent use of technology in the classroom was students' creation of products. A factor analysis of all applications yielded nine factors of alternative functions for using the applications: (a) instruction; (b) communication; (c) creativity; (d) organization; (e) quantitative/analytic; (f) expansive; (g) programming and design; (h) project or product development or creation; and (i) high tech, multimedia, and games. The teachers reported three perceived changes in their classrooms:

1. They expected more of their students and presented more complex material.
2. They met the needs of individual students better.
3. Their classrooms became student- rather than teacher-centered.

The researchers added that it was not technology alone that caused the change, but the varied opportunities for using technology that contributed to a change in the construction of the learning environment by teachers. The teachers in the study were identified not as representing the classroom norm but as individuals who represented the potential impact of technology on the learning environment (Hadley & Sheingold, 1993).

The heart of any effort to improve education in our society is teacher learning. While efforts to reform education have proliferated, efforts to promote teacher learning that lead to improved practice on a wide scale have not emerged. It is the teacher who ultimately chooses from among the variety of reforms, most of which have creators who have ignored the time and effort required for implementation. If changes in classroom practices are to take place it will be important that resources are generated to support these practices (Sikes, 1992).

Teachers have been called the "front line in the battle for school improvement" (Schmoker, 1996). They need to base their judgments on "knowledge of learning theory and pedagogy, of child development and cognition, and of curriculum and assessment" (Darling-Hammond, 1993, p. 757). Ongoing professional development of teachers has been identified as a key to the school reform agenda (Darling-Hammond, 1993; Fullan, 1991; Lieberman & Miller, 1991; Joyce, Wolf, & Calhoun, 1993).

### Directions

Against the backdrop of more powerful uses for technology and calls for restructuring the education process, are two topics that have increasingly come under discussion: a body of learning theory called constructivism, and a use of technology to provide powerful learning environments within a distance education setting.

The focus and intent of this book is to assist K-12 teachers and teacher staff developers in the application of constructivist tenets and design principles to K-12 distance education learning environments. Much of teachers' views of teaching and learning have evolved from time they spent as students sitting in classrooms devoted to the acquisition of particular facts.

rules, and attitudes selected by the teacher and delivered to the students (Greene, 1991).

Teachers tend to teach as they were taught. For many this means choosing “to keep order and to disseminate as many bits of knowledge as they can” (p. 11). This is quite different from choosing to develop a classroom in which knowledge “can be sought and meanings pursued” (p.11) through the use of dialogue that encourages students to pose their own questions, pursue their learning paths, and collaborate with others to construct new knowledge and learn how to learn. If teachers are expected to change their classroom practice they will need training and on-going support (Joyce & Showers, 1988; McLaughlin, 1991). This book can be used to support distance education staff development opportunities or to provide a continuing resource for teachers as they develop their own distance education classrooms.

### Learning Theories

How instructional designers (i.e., in a K-12 setting, the teachers) view the roles of the various components used to create a learning environment depends on their beliefs about how people learn. Learning theories provide a foundation for much of the curricular and instructional decision-making that occurs in education (Fosnot, 1996). It is important to understand the role of learning theories and how they impact teaching and learning decisions. Bednar, Cunningham, Duffy, & Perry (1992) supported this idea when they suggested that “instructional design and development must be based upon some body of learning theory and/or cognition; effective design is possible only if the developer has developed reflexive awareness of the theoretical basis underlying the design” (p.19). In other words, instructional design could be facilitated by understanding theories of learning.

Educators’ belief systems about how and what students should learn influences their practice. Their understanding of beliefs about the nature of learning assists in the selection of concepts and strategies consistent with those beliefs. Theories can help teachers to understand why they do the things they do or explain why something happens. Learning is so complex an activity that no one theory entirely explains it (Bredekamp & Rosegrant, 1992). There are a

number of theories that can assist teachers as they plan for the creation of a learning environment. One body of theory that is receiving much attention in education is constructivism (see, e.g., Duffy & Jonassen, 1992). The following review is provided to assist the reader in understanding constructivism and its impact on the learning terrain.

### Constructivism

Constructivism is a body of theory about knowledge and learning; it describes both what "knowing" is and how one "comes to know." A constructivist sees knowledge as "temporary, developmental, nonobjective, internally constructed, and socially and culturally mediated" (Fosnot, 1996, p. ix). Learning becomes

a self-regulatory process of dealing with the conflict between existing personal models of the world and discrepant new insights, constructing new representations and models of reality as a human meaning-making venture with culturally developed tools and symbols, and further negotiating such meaning through cooperative social activity, discourse, and debate (p. ix).

Learners construct their own reality or at least interpret it based upon their prior knowledge and personal experiences. Thus, an individual's knowledge is a function of prior experiences, mental structures, and beliefs that are used to interpret objects and events (Bredo, 1994; Jonassen, 1994).

Two of the trends identified in constructivist-based education research are cognitive constructivism and sociocultural constructivism. The first is focused on the activities of the individual's engagement in the learning process. The second is focused on the socially- and culturally-situated nature of activity in which the individual participates as a part of the learning process (Cobb, 1996). The research and writing of Jean Piaget and Lev Vygotsky have strongly influenced the two perceptions.

Cognitive Constructivism. Cognitive constructivists find Piaget's work supportive of their view of constructivism. Piaget focused on the individual cognitive knowledge structuring

process. Although Piaget's theory is not a theory of education, it does provide a framework for analyzing educational practices and the extent to which they are consistent with his theory of development (Wadsworth, 1996). Piaget was interested in studying what occurred inside of the minds of individuals as they encountered a discrepant environment, thereby causing a sense of disequilibrium. He envisioned learning as a process of self-organization during which the learners reorganize a schema in order to eliminate perturbations based on individual perceptions (Cobb, 1989; Phillips, 1969; Seefeldt & Barbour, 1994). Knowledge construction becomes an individual invention, a process not of recreating a model, but of inventing it. The teacher's responsibility is to create environments which cause this disequilibrium and then assist the learners in their re-establishment of equilibrium. The social interactions of students within the environment provides opportunities to become aware of differences in perspectives and offers intrinsic motivation to adapt these into personal schemata (DeVries & Kohlberg, 1990). It is this personal process of accommodation and adaptation, caused by these interactions, that leads again to equilibrium and leads to increasingly complex schema.

Piaget believed that the learner's developmental level impacted what could be learned and the level of possible comprehension of that learning (Wadsworth, 1996). The development of schema precedes the learning of logically or systematically organized concepts (Panofsky, John-Steiner, & Blackwell, 1993). In educational settings, developmental level is only one of the concerns. Education is also about skill acquisition and content learning. Cognitive constructivists believe that when there is compatibility between the learner's developmental level and the skills and content to be learned, learning is enhanced. According to Piagetian theory, a learner is cognitively ready to construct a particular concept when, and only when, the internal motivation, appropriate schemata, and general level of reasoning are present. Thus, there is not a "cookbook" approach to design. Rather, environments are designed to be responsive to the varying levels and needs of individuals. This responsiveness does not happen

by accident. Schools and teachers must create environments that are responsive to individual learning needs (Wadsworth, 1996).

Sociocultural constructivism. Sociocultural constructivists support Vygotsky's, rather than Piaget's, view of the acquisition of knowledge. That view suggested that knowledge is acquired from the culture by the learner through social interactions with more knowledgeable individuals and other learners. Language plays a central role in human learning. It makes it possible to share experiences, to link our minds and produce a social intelligence superior to that of any one individual. Learning becomes a shared vicarious experience through language (Goodman & Goodman, 1993). Vygotsky believed that intellectual development was fundamentally influenced by social factors rather than the converse. He posited that the learner's internalizing of the knowledge, which exists within society, causes intellectual skills and functions to be developed (Wadsworth, 1996). The learning of systematic concepts precedes the development of an "elaborated logical structure" (Panofsky, John-Steiner, & Blackwell, 1993, p. 253).

The sociocultural constructivist focuses on the kinds of social engagements that increasingly enable students to be involved in the activities that resemble those of an expert in the area under study. It is precisely the interactivity between and among the environment, student, instructor, and knowledge that facilitates the construction of new knowledge (Cobb, 1996). Vygotsky emphasized that what the students do collaboratively or with assistance today, can be done independently and competently tomorrow. He believed that "maturing or developing mental functions must be fostered and assessed through collaborative activities, not independent and isolated activities" (Moll, 1993, p. 3).

Vygotsky agreed with Piaget that learning was developmental, but that it was the learning of culturally modeled concepts which lead to development, instead of level of development impacting what could be learned (Wadsworth, 1996). Development and instruction were both seen as socially embedded by Vygotsky. The interaction between the

teacher and student is the social organization of instruction. Cooperation between the students and the teacher is viewed as a central element of the educational process (Moll, 1993). To formalize a view of the process of knowledge construction, Vygotsky developed the concept of the Zone of Proximal Development (ZPD).

Vygotsky proposed that each child, in any domain, has an actual developmental level where spontaneous or everyday concepts occur, allowing the child to function independently. The actual developmental level can be assessed and the possibility for further development created through experience with scientific concepts under adult guidance or in collaboration with capable peers within that domain (Fosnot, 1996). The difference between the level of independently solved tasks and tasks that can be performed with the facilitation of an adult or capable peers is the ZPD (Hedegaard, 1993). It is the responsibility of the teacher to assess both levels in the learner and then create learning environments that allow participation in activities with the appropriate individuals. Through instruction, the scientific concepts become the child's spontaneous concepts (Hedegaard, 1993). The degree to which the child masters the scientific concepts shows the level of development.

Differences and Similarities. While Piaget and Vygotsky approached the construction of knowledge in different ways, there are similarities in their views. Both saw:

- knowledge as adaptation and as an individual construction
- learning and development as self-regulated
- active involvement of the developing/learning child as being required, and that
- development/learning was not automatic (Wadsworth, 1996)

Both the cognitive and sociocultural constructivist perspectives are viable; use of one over the other in curriculum development will be based on individual beliefs about the learning process. Implied in both is the idea that there is not access to an object reality because the learner constructs his or her own version of it either individually or through interactions with others. Concurrently, as the learner transforms the information, the learner is also changed.

Cognitive theorists analyze thought in terms of the conceptual process located in the child while sociocultural theorists take the individual in action with others as their unit of analysis. The cognitive perspective focuses on both what students learn and the processes by which they do so, while the sociocultural perspective addresses the conditions that contribute to the possibility of learning (Cobb, 1996). Awareness of both perspectives provides the instructional designer with a broader view of the interactions of the individual with the knowledge and the environment.

### Theory-Based Design

Application of constructivism into the learning environment will be directly impacted by a teacher's perception of the theory. Interpretations of constructivism can be found in an individual's identification and definition of its tenets. The term "tenet" has been defined as a doctrine, opinion, or principle held as being true by a person or by an organization (StarPress, 1993). A number of descriptions of constructivism and its tenets have been contributed through multiple print "discussions" of constructivist-based learning environments. The following list, drawn from those discussions, includes the word tenets because it is this author's composite of those contributions. The tenets are presented as a broad picture of the constructivist domain. Appendix A charts the analysis of the tenets identified in the print discussions.

### Tenets of Constructivism

- Goal Oriented: Learning focus can be established by the teacher or negotiated as part of the discussions with the student. With the goal being learning, the learner organizes her or his activities and resources in order to achieve the goal (Duffy, Kremer, and Savery, 1993; Shuell, 1988)
- Active or Generative learning: Students use mental exploration to relate new information to prior knowledge in order to build more elaborate knowledge structures (Cognition and Technology Group at Vanderbilt, 1991; Jonassen, Mayes, & McAleese, 1991).



- Cognitive Conflict: The resolution of the knowledge “gap” results in new ways of thinking about reality; acting on, not taking in, experiences. Learning occurs as people build more elaborate schemata to clarify their experiences (Jonassen, Mayes, & McAleese, 1992; Winn, 1991).
- Prior Knowledge: Learning construction is cumulative, nothing has meaning or is learned in isolation. Knowledge is constructed by interpreting experiences in terms of what one knows, current mental structures, and existing beliefs (Shuell, 1988; Jonassen, Mayes, & McAleese, 1991).
- Situated or authentic learning and instruction: Learning and instruction is positioned in realistic and relevant problem solving contexts that allow sustained exploration by students and teachers, enabling them to acquire skills or knowledge in order to solve the problem or manipulate the situation (Cognition and Technology Group at Vanderbilt, 1991; Cunningham, Duffy, & Knuth, 1993).
- Social Negotiation of Meaning: Students are provided opportunities to revisit a concept through multiple perspectives found within the learning community as they create new meanings and transform old ones. Also, the viability of ideas is tested in light of peers’ ideas during collaborative activities. The learning community is provided opportunities to create shared meanings that constitute a body of knowledge for the community (Jonassen, Mayes, & McAleese, 1991; Lebow, 1993; Prawat, 1992; Winn, 1991).
- Learner Controlled: The student self-governs knowledge creation within the learning environment. Learning control is focused at the learner level through teachers encouraging learners to have ownership and voice in the learning process (Cunningham, Duffy, & Knuth, 1993; Marra & Jonassen, 1993; Strommen & Lincoln, 1992).
- Novice to Expert Learning Continuum: Learners can be located along a continuum from novice to expert based on the amount of learning about a discipline they possess.

Learners move from concrete explorations in meaningful contexts, to symbolic representations of these actions, to abstract models. Teachers facilitate novice learners' lack of internally coherent and richly interconnected knowledge structures by assisting in selection and use of strategies necessary for learning (Fosnot, 1992; Jonassen, Mayes, & McAleese, 1991).

- Teachers as Knowledge Facilitators: Teachers determine where an experience is heading based on their subject matter knowledge and the student's experience. In addition they listen as students engage in examination and explanation of phenomena and question students about their decisions made during the learning process. Teachers serve as a guide, engaging students by helping to organize and assist them as they move towards taking the initiative in their own self-directed explorations. Teachers provide scaffolds to help less-skilled individuals or groups begin to explore ideas without going too far astray, yet eventually helping them become self-directed generators of knowledge (Brooks & Brooks, 1993; Cognition and Technology Group at Vanderbilt, 1991; Prawat, 1992; Strommen & Lincoln, 1992).

- Connectedness of Knowledge: The interactions among pieces of knowledge and subskills, not merely their acquisition, determine what is learned. Knowledge is the sum of encounters and the relations established by the student within the content domain. Understanding is not mastered but can be deepened as ideas and models are extended to new experiences forming more complex knowledge structures. Learning is structured around conceptual clusters of problems, questions, and discrepant situations which form big ideas in a whole-to-part manner (Brooks & Brooks, 1993; Fosnot, 1992; Shuell, 1986; Winn, 1991).

- Reflexivity: The development of awareness of and control over the personal knowledge construction process; to know how one knows; the careful study of processes by which a learner creates and develops ideas (Cunningham, Duffy, Knuth, 1993; Strommen & Lincoln, 1992).

These tenets provide a total picture that depicts the role of instruction as providing students with the power and the environment to assemble and acquire knowledge, not to

dispense information. For the purposes of this book, the embodiment of the knowledge construction process will be discussed within the framework of the learning environment.

### Learning Environments

Learning environments refer to a class of systems that integrate, to varying degrees, tools, resources, and pedagogical features for increasing comprehension (Hannafin, 1992). A learning environment is a place where the learners can draw upon resources to make sense out of things and construct meaningful solutions to problems (Wilson, 1996). While learning environments' initial definitions have not included references to constructivism (Hannafin, 1992; Duchastel, 1994), their definitions do offer opportunities for use by constructivist educators.

According to Hannafin (1992), learning environments share four dimensions: scope, content integration, user activity, and educational activity. Each dimension occurs as a continuum, and the learning environment will possess attributes along each continuum. The four areas are defined as:

1. Scope: the inclusiveness of the environment, both the content covered and the extent to which educational features are available to the learner.
2. Content Integration: the manner in which integration occurs can vary widely from cross content integration, where integration may be among allied knowledge or concepts to within content integration, which promotes the exploration of multiple perspectives within the domain.
3. User Activity: the level of the user activity where generative environments rely on the learner(s) to create, elaborate, or otherwise represent knowledge, while mathemagenic environments structure the content externally offering multiple ways to permit student learning.
4. Educational activity: the nature of the educational activity moves from goal-directed exploration to student-directed exploration.

Attention to each of these areas and the continuum's they represent, coupled with a supportive learning theory, will assist the designer in the creation of effective learning environments.

Duchastel (1993-94) expanded the definition of learning environments, offering four additional components needed to support effective learning environments.

1. Information: access to learning materials and learning resources both material and human.

2. Interest: sensory effects which attract attention and structure the information itself to keep the learner on task.

3. Structure: cognitive maps such as themes, content lists, goals, problem sets, etc. which assist in the building and refinement of cognitive models necessary to the internal understanding of the facets of the world:

4. Regulation: learner control performed internally (through self monitoring) and externally (through questions and problems) which allow a maintenance of the proper level of interplay between information and the learner's current cognitive structure.

A combination of the components provide a picture of a setting constructed to support and stimulate the learner, not to control or dictate to the learner. Hannafin provides a continuum used to show the learners movement towards increased comprehension while Duchastel identifies the components that should be included in the learning environment to increase comprehension. The image of an effective learning environment created is one in which individuals do not merely participate in lessons, they assume an active role in knowledge construction (Hannafin, 1992). A learning environment, then, is a place where "individuals can use available resources to make sense out of things and construct meaningful solutions to problems" (Wilson, 1996, p.3).

### Constructivist Learning Environments

The addition of "constructivist" to the term "learning environment" emphasizes the importance of authentic, meaningful activities developed to assist the learner in the construction

of understandings (Wilson, 1996). Constructivist learning environments (CLEs) can be described as settings that are intended to support and stimulate the learner, making ideas accessible, avenues apparent, mysteries inviting, and problems approachable (Perkins, 1996). The teacher and the student serve as co-task masters of the learning. The use of construction kits and phenomenaria (Perkins, 1991) place more control of the environment with the learner. Students typically engage in more complex activities while working towards various learning goals. Wilson (1996) offered a definition of CLEs as a launching point rather than a finite definition, thereby acknowledging the fact that constructivists will interpret the term based on their own knowledge and beliefs.

One definition of a constructivist learning environment then would be:

a place where learners may work together and support each other as they use a variety of tools and informational resources in their guided pursuit of learning goals and problem-solving activities (p.5).

Whatever the definition, CLEs' development hinges on the methods and tools available to create these "places" of learning. Resources for development can be found in the domain of Instructional Design.

### Instructional Design

Instructional design as a discipline deals with understanding and improving the process of instruction. Instruction is the planned combination of teachers, students, and information, and the methods, media, and equipment needed to convey information and guide the learning (Heinich, Molenda, Russell, & Smaldino, 1996). All effective instruction requires careful planning.

In a K-12 setting, the teacher is normally responsible for arranging instruction. However, it is possible that the instructor and a separate instructional designer or a design team may be responsible for the process. This arrangement does occur in distance education. The instructional designer or team develops a course based on input from the instructor. The

purpose is to develop optimal methods of instruction that bring desired changes in student knowledge, skills and affect (Lin et al., 1996). The designer's role is to determine or find out as much as possible about the intended outcomes, the learning environment, and the students, and then select or develop instructional methods that will help students attain the intended outcomes. Therefore, instructional design proceeds from a series of "instructional principles" (Reigeluth, 1983).

### Principles for Design

A principle makes a statement about the outcomes, conditions, and methods used to attain instructional goals, showing how one action is related to another action. Principles are used to guide the designing of learning environments as well as the practice of teaching (Savery & Duffy, 1996). As a body, the principles a designer uses embody the theory of instructional implementation used to develop the learning environment (Winn, 1991). Because the purpose of instructional design is to create plans for learning, design principles prescribe what instructional methods may be used in relation to the goals and conditions of learning. The guiding principles provided in this book evolved out of a cyberconversation between a number of knowledgeable constructivists and instructional designers. As a body, the chapters in the book provide a guide for the design of constructivist-based distance learning environments.

### Models of Design

Traditionally, models of instructional design have treated instruction as a systematic process of instilling or communicating some content and/or set of skills to the student. Learning environments have been engineered so that transmission of knowledge from these sources was effective and efficient. Knowledge was seen as external to the learner and objectively specified. Errors were seen as identifiers of additional instruction or remediation. Now, because of the impact of societal changes, educators are being asked to change their classrooms, moving from a focus on sorting students to one focused on student learning (Reigeluth, 1996). A number of recent books (see e.g., Duffy & Jonassen, 1992; Duffy,

Lowyck, & Jonassen, 1993; and Wilson, 1996) explore the implication of constructivism for instructional design.

Constructivist instructional design promotes the creation of environments in which the learners actively construct their knowledge, rather than reproduce the teacher's interpretation of that knowledge. It has been suggested that instruction in the traditional sense is not possible, that teachers do not attempt to change students, instead they design environments that offer students the opportunity to thrive, respond, and change themselves (Brooks & Brooks, 1993; Jonassen, Myers, & McKillop, 1991; von Glasersfeld, 1991). Learners construct their own understandings by actively participating in and interacting with the learning environment to develop their own view of the subject, rather than relying on and reproducing the teacher's interpretation of the world. In order to understand the construction of student-centered environments, a design process should be examined.

Constructivism offers instructional designers an alternative set of tenets to guide learning environment design. The traditional tenets of replicability, reliability, communication, and control suggested by instructional designers are in contrast to constructivist tenets of collaboration, learner control, generativity, reflexivity, personal relevance, and social negotiation of meaning (Lebow, 1993). Constructivists emphasize the design of learning environments, rather than the design of instructional sequences. However, if designers adopt constructivist principles it does not mean that they necessarily abandon "traditional" strategies. Designers should choose the best strategy to use and that choice is dependent on the instructional context and the needs of the students (Marra & Jonassen, 1993).

A common misconception about constructivist learning environments suggests that if students construct their own knowledge, there is nothing to design. In fact, a number of constructivists have determined that learning does need organization, indicating that students need some form of guidance in their search for meaning (see, e.g., Duffy, Lowyck, & Jonassen, 1993; Fosnot, 1996; Wilson, 1996). However, they do not believe that the

“determination of the exact contribution of each [component] to the exact outcome” (Dick & Carey, 1990, p. 4) of instruction can be carried out a priori to the learning experience. Rather, the task of educators is to monitor and facilitate students’ knowledge construction through the ongoing creation of appropriate learning opportunities and incentives. To carry out this charge, teachers will need a broad base of knowledge and instructional strategies. For many, this will mean a need for more training and mentoring.

Constructivists have suggested that a learning environment design can be developed based on the following concepts:

1. Identification of objectives: Objectives, in this case, focus on “learning to learn” and are based on “big ideas” or “deep principles” that underlie specific content areas. They are open-ended objectives with criteria for success that are formed collaboratively through a student and teacher negotiation process. They give direction to the shell (i.e., learning environments that can contain anything a teacher or student wishes to place in them) which the student will use to move around inside the knowledge domain (Winn, 1993).
2. Assessment of both students’ prior knowledge and ongoing development of understanding: The objective is to build on students’ current understandings. Evaluation becomes a tool to identify how much and what kind of help students need to accomplish a task successfully within the context of the learning environment. The learners themselves are regarded as an integral part of the assessment process. The appropriate assessment for contextualized learning is manifested in the performances it enables and/or the products it produces (e.g., portfolios of work, project reports, oral presentations, experiments, written essays, and demonstrations) (Reeves & Okey, 1995).
3. Provision of the context for learning: Within an authentic context, the use of “big ideas,” allows students to identify and define the issues related to the “idea” and then to seek relevant resources to support knowledge construction. The teacher may provide the authentic context like the Jasper videodiscs (Cognition and Technology Group at Vanderbilt, 1993),



which provide a video and problems to be solved by students. All data needed to solve the problem are included in the video as a natural part of the story. Teachers may also provide a situation that requires students to construct the context. The use of bubble dialogue opens to students the selection of characters and opportunity to use bubbles to identify what the character is saying or thinking as they create comic strip-like documents allowing students and/or teachers to interact and reflect during the learning process (McMahon & O'Neill, 1993).

4. Identification of instructional strategies: Instructional strategies typically used in constructivist learning environments involve strategies for organizing the activities of students rather than strategies for delivering information. The design process is informed and enhanced by the teacher's understanding of the cognitive demands implied by certain curricular tasks. At one end of the instructional strategy spectrum one might find methods used so that students explicitly learn skills such as reading, writing, and computing needed to complete tasks. At the other end of the spectrum one might find the use of authentic problem solving and opportunities to conduct research on self-selected topics both of which are identified as methods that can enhance student motivation. Whatever strategy is chosen, its selection must be based on the needs and interests of the student (Brooks & Brooks, 1993; Lin et. al, 1995; Winn, 1993). These guidelines are based on the belief that students' learning does need to be facilitated by the more knowledgeable teacher. The intent is not to find out what a student can repeat, but to provide opportunities for the generation, demonstration, and exhibition of new knowledge.

In the instructional design literature, concerns that instructional design models are discrepant with practice are growing (Rowland, 1993). These concerns mirror the calls of reformers that the practice of schooling is discrepant with the needs of society. Through discussion, study, and research new descriptions and models said to be more responsive to the needs and complexities of the "real world" are emerging. Technology is predicted to be an

integral component of the future "real world." Its use is changing and expanding the learning environment.

### Distance Education Technology

The vehicles for traveling in educational cyberspace will be found in the forms of technology that are available to teachers and students. It is difficult to anticipate what vehicles will emerge in the future, making it difficult to speculate on learning designs for future classrooms. What is known is that there are a number of technologies available for educational use (e.g., computers, modems and networks, VCRs and educational video, CD-ROM and videodiscs, distance learning networks via satellite, microwave, and fiber optic systems) and more are on the horizon. New media has the potential to "create new forms of literacy and rhetoric: mastery of these is central to success in the post-industrial workplace" (Dede, 1995a, p. 23). It has been predicted that educational tools that empower knowledge construction by unsophisticated learners will serve as a resource for enriching the information environment of many schools, helping to make sense of massive amounts of information, and modeling new pedagogical strategies for teachers and parents while aiding individuals (Dede, 1995a). However, if too much emphasis is placed on hardware acquisition without regard to corresponding staff development, the hardware will be underused. It is apparent that the merging of technology with a learning theory such as constructivism will require that traditional roles of teachers and students change.

Educational technology enables a broad range of complex activity to support change efforts. In the past, technology was all too often used "to do in a slightly different way what had been done without it" (Papert, 1980, p. 36). For many, the role of technology in the classroom has been one of delivery or controlling of instruction. As alternative teaching and learning approaches are designed, alternative roles must also be addressed for technology. These roles include facilitation of students' thinking and support for students' knowledge

construction within the learning environment. Jonassen (1996) offered suggestions for the roles of technology to support constructivist views of learning:

- Technology as tool: for accessing information; for representing ideas and communicating with others; and for generating products.
- Technology as intellectual partner: for articulating what learners know, i.e., representing their knowledge; for reflecting on what they have learned and how they came to know it; for supporting the internal negotiation of meaning making; for constructing personal representations of meaning; and for supporting mindful thinking.
- Technology as context: for representing and simulating meaningful real-world problems, situations, and contexts; for representing beliefs, perspectives, arguments, and stories of others; and for supporting discourse among a knowledge-building communities of learning (p. 62).

For technology to support changes in the design of learning environments, its role must be examined. No longer the delivery truck of information, technology can now be a partner in the students' construction of knowledge. Understanding the various roles it can play will help the teacher and student use it to create empowering environments for learning (Jonassen, 1995). Figure 1 relates technology's use to some of the teaching strategies currently suggested as supportive of these reformed and empowered environments.

The selection of technology that supports and empowers the learner can be difficult. It is important to understand how the role of technology is used as a tool to support that learning. Appropriate selection should not only be based on the availability of technology but on its power to assist the learner. The information contained in Figure 1 identifies the type of technology that can provide support to various teaching strategies. It is a useful tool for the instructional designer who is charged with the integration of technology into the learning environment.

Teaching Strategies							Potentially Supportive Technology
1.	Heterogeneous Groupings						<p>Numbers 1 - 7 represent various teaching strategies. Types of technology that can potentially support the implementation of the teaching strategies are listed below</p> <p>A button on of the left side columns indicates the strategies each type of technology can support.</p>
2.	Performance-Based Assessment						
3.	Authentic and Multidisciplinary Tasks						
4.	Collaborative Work						
5.	Interactive Modes of Instruction						
6.	Student Exploration						
7.	Teacher as Facilitator						
1	2	3	4	5	6	7	
							Electronic Databases
							Electronic Reference Tools
							Hypermedia
							Intelligent Computer-Assisted Instruction
							Intelligent Tools
							Microcomputer-Based Labs
							Microworlds and Simulations
							Multimedia Tools and Approaches
							Networks and Related Applications
							Two-way Video Two-way Audio Distance Learning
							Videocameras, VCRs, Editors
							Videodisc and CD-ROM
							Word Processors Intelligent Writing Tools

**Figure 1.** Teaching strategies and examples of supportive technologies. Examples of applications for each technology type are given in the original source. Adapted from "Features of Educational Reform and Supportive Technologies," by Means et al. (1993), p. 35-36.

### Teachers, Learning, and Technology

The 1990s have ushered in more powerful and flexible technologies for teachers, increasing their opportunities for use in the classroom. Research is now showing that the learning environment can be impacted by the introduction of technology but that the change is not instantaneous. Research by Hadley and Sheingold (1993) found that following five to six years of tinkering and efforts to achieve competency with technology, educators began to use computers more as tools rather than tutors. The researchers suggested that their findings are supported in the results of Sivin-Kachala and Bialo's meta-analysis of reviews and research on technology's use.

A key to becoming comfortable with the expanded role technology can play in learning is time (Adelman & Walking-Eagle, 1997; Joyce & Showers, 1988; NSDC, 1995). The Apple Classrooms of Tomorrow (ACOT) project is a consortium of researchers, educators, students, and parents whose mission is to "explore, develop, and demonstrate powerful uses of technology in teaching and learning" (Dwyer, Ringstaff, & Sandholtz, 1991, p. 46). ACOT studies found that teachers' beliefs and practices changed over time. Initially, teachers used computers to strengthen "text-based curriculum delivered in a lecture-recitation-seatwork mode" (Dwyer, Ringstaff, & Sandholtz, 1991, p. 47). Eventually, computers' roles have evolved into supporting active and creative learning environments. Teachers shifted from the role of information presenters and into the role of learning mentors as students took more responsibility for their own learning. These reports showed the potential technology has to change the way we go about teaching and learning in the classroom. Against this backdrop, we find a powerful emerging technology that has the potential to expand the learning opportunities for teachers and students: telecommunications technology.

### Telecommunications

Telecommunications networks are systems for communicating over a distance. A number of forms of telecommunications are used to transmit or receive signals for voice, video

and data communications (e.g., radio, telephone, television [broadcast, wired, and satellite], and computers). What they all have in common is implied in the Greek root work tele, which means "at a distance" or "far off": that is, they are systems used to communicate over a distance (Heinick, Molenda, Russell, & Smaldino, 1996).

The use of telecommunications has already revolutionized the way our cars are serviced. The General Motors Computer Aided Maintenance System (CAMS) is an example of what computer engineers call an "expert system" that links repair bays in dealers' garages via telecommunications to CAMS core, a mainframe computer. Its purpose is to take data directly from electronic testing instruments, ask and answer questions, and prescribe corrections for car's problems. Mechanics have on-line education as they "learn" from the CAMS responses. CAMS is the forerunner of 21st century learning systems where vast volumes of data are accessed, and where knowledge is ascertained then applied to real world problems. Networked systems like CAMS allow intelligence to be distributed beyond the boundaries of space and time (Perelman, 1992).

Access to basic telecommunications technology (e.g., computers, modems, and phone lines) as well as more advanced forms of technology (e.g. fiber optic and teleconferencing systems) have been suggested as essential components of the educational reform agenda (Means et al., 1993; Papert, 1992). Nineteen-ninety six data showed that telecommunications are making significant headway in school districts. Seventy-six percent of all U.S. schools had cable access, sixty-two percent had Internet access, and thirty-five percent had satellite access (Quality Education Data, 1996). It has been predicted that technological advances for educational uses will be monumental (Portway & Lane, 1994). Four factors which could impact the learning environment due to these advances are:

1. voice, data and video delivered into the home, community learning centers, workplaces via cable television;
2. access to worldwide information via telecommunications;

3. access to worldwide dialogue via telecommunications; and
4. learning through entertainment-like devices (Portway & Lane, 1994).

These four factors combine to produce a picture of a global learning environment within classrooms where the typical locus of educational activities can be literally inverted.

Classrooms can face outward towards the world instead of inward towards encapsulated islands of learning. The use of telecommunications systems connects teachers and students to large databases, vast resource pools, and opportunities to participate in joint activities with individuals in other states and nations (Portway & Lane, 1994).

Unfortunately, teachers are not receiving the training necessary to integrate the use of these technologies into their curriculum. Teachers report that their schools now have computer "training" available; however, training for telecommunications is virtually nonexistent. Honey and Henriquez (1993) identified that eighty-eight percent of telecommunication-using educators in their study were self taught. Seventy-eight percent of these educators started using the technology because of personal interest and motivation rather than school or district initiatives. Ironically, the advent of new and more advanced technology has not been supported with training. The researchers found very little support for telecommunications training at the school (8%) or district level (13%).

The combination of a telecommunications system with an education system can expand the scope of education. But, it will take time and practice for teachers to learn its effective use. Schools are and continue to increasingly tap into the power of telecommunication. The combination of telecommunications and education creates a derivative of a brand of education that has been serving learners for centuries: distance education.

### Distance Education

Distance education is not a recent innovation in education. An early recorded enterprise using the new technology of a "mail service" as an aid to education is seen in an advertisement in the Boston Gazette on March 20, 1728. Teacher Caleb Philips offered to send weekly

shorthand lessons to prospective students. In 1873, Anna Eliot Ticknor organized a correspondence school called the "Society to Encourage Studies at Home." The school was targeted at educating young women, many of whom were kept at home by the conventions of their time. William Rainey Harper is credited with the creation of modern correspondence education. As president of the University of Chicago in 1892, Harper directed that the university include a department of correspondence study (Mood, 1995). As the use of radio began to expand, it was regarded as an instrument of instructional change. A statement from the State University of Iowa to the Federal Radio Commission, in 1927, suggested that "it is no imaginary dream to picture the school of tomorrow as an entirely different institution from that of today, because of the use of radio teaching" (Pittman, 1986, p.4).

The "second generation" of distance education began in the 1950s with the advent of television's Sunrise Semester. However, it was the granting of a Royal Charter to The Open University of the United Kingdom in 1969 that instilled and expanded a new concept of distance education. What began as a mix of correspondence instruction, broadcast and recorded media, has grown into an entity that distributes courses through television to more than 130,000 students (Moore and Kearsley, 1996).

Instructional Television Fixed Service (ITFS), a low cost microwave distribution system, was put into service by the Plainedge School System in 1961. Presently, more than 100 educational licensees operate several hundred channels over the microwave frequency spectrum (2500-2690 MHz) reserved for educational use. This system usually offers one-way video with two way audio up to 20 miles from its origination site. Satellite one-way transmissions began to see use in the 1970s. The University of Alaska initially offered continuing education courses for teachers. The Alaska Department of Education now offers programming via satellite to 113 elementary and secondary schools with receive capabilities. The National Technological University is a program established in 1985 to deliver graduate and



continuing education courses, via satellite, to an initial 25 universities. Today, the degree-granting consortium distributes to 45 universities.

Distance education at the K-12 level began receiving support in the 1980s from the U.S. Department of Education's \$100 million Star Schools project. The project's purpose was to promote the use of telecommunications to support instruction in math, science, foreign language, language arts, and vocational education in rural, disadvantaged, and small schools. A stipulation of the program was that state-level partnerships must be formed. The formation of these networks have served to strengthen distance education networks across the nation. Ten state or nationwide projects have been supported by Star Schools grants.

Initially, the Star Schools grants required satellite use to be an integral part of the projects. However, in 1992, the state of Iowa was granted money for teacher training and K-12 course distribution over the state owned Iowa Communications Network (ICN). The ICN is a state-owned two-way audio, video and data transfer fiber optic system. Its development is representative of the next level of telecommunication networks supporting distance education.

#### New Directions

At the next level, telecommunications networks are combining voice and audio transmissions with access to the information superhighway (i.e., a worldwide fiber optic network that can simultaneously transmit voice, data, and video). Teachers' and students' channels of communication are no longer limited in these new environments. Interaction is available in multiple forms of virtual face-to-face settings or within the powerful world of electronic mail, the World Wide Web, bulletin board systems, and information resources.

Teachers and students, in many cases, are no longer separated by time and place within the distance learning environment. Now, only place separates people increasing the potential for ongoing interaction between and among students and teachers. The greater the opportunity for interactivity, the greater the level of feedback that can be communicated to motivate and individualize the learning (Dede, 1991). The increased interactivity via more interactive delivery

systems requires a reexamination of the skills, knowledge, activities, and attitudes for creation of learning environments at a distance.

In the beginning of distance education, individual interaction was the dominant form. As technological capabilities have grown, social interaction has increased in importance for distance education. As such, opportunities for constructivist-based distance learning environments have increased. The multiple capabilities of these environments opens for constructivists many avenues to develop learning environments which support student exploration and structuring of the knowledge domain. With multiple strategies available, the learning is not constrained by the medium but can be supported and expanded through the medium.

As distance educators seek to respond to the changing nuances of the genre, new definitions of distance education are evolving. Dede (1987, 1991) focused on the impact of teacher, student, and environment on the learning process. He titled this type of distance education as technologically-mediated interactive education (TMIL). Dede (1991) explained that TMIL encompasses:

1. A technological medium that either interposes between direct person-to-person interaction or provides a shared environment that shapes the process of interpersonal communication.
2. Technology that provides the tools and experiences that enhance the collective learning of the people involved, as well as their individual accomplishment;
3. Human participants' interaction that is spontaneous.

The addition of "learning" to this definition puts the focus on the construction of knowledge, not just the parameters necessary to identify a distance education setting. At one extreme, TMIL could be a group of students sitting in the same location interacting around a technology-created experience developed for team learning. At the other end of the spectrum, a group of

geographically separate learners could be communicating through computer conferencing or a fiber optic network (Dede, 1991).

Within a reconceptualization on the process of learning, the most productive and meaningful learning environments can be found to engage learners in: (a) knowledge construction, not reproduction; (b) conversation, not reception; (c) articulation, not repetition; (d) collaboration, not competition; and (d) reflection, not prescription (Jonassen, 1995). Technology then is not treated as a delivery system but as a tool and intellectual partner to facilitate thinking and knowledge construction. The capabilities of advanced technology can enable these strategies in a TMIL environment while the theory of constructivism can provide a strong foundation for the incorporation of these ideas into the learning environment. The combination of these elements allows for a reconceptualization of education's mission, clients, methods, and content.

An example of the future potential for TMIL is the immersive distributed virtual environment (i.e., technological environments allowing people separated by distance and/or time to occupy a world where they can collaborate to develop common virtual experiences). These TMIL environments open the opportunity for students to experience things that are not readily accessible in the real world (Dede, 1995b). An example would be the use of distributed virtual environments by students from around the world to practice or collaborate on each others' language, math, science, or communication skills, as their graphic personas work on the deck of the starship Enterprise trying to move the starship out of harm's way. The complexity of the setting requires students to select and pursue an individual path of learning. The students are immersed in responsive environments in which they have become engaged in full body-mind kinesthetic learning. The realistic nature of the setting and ability to individualize the learning can prove to be motivating to the student. The teacher's role in this world is to facilitate students' connections between learning gained in the virtual world and to assist in the application of the learning to the educational goals of the activity. As a result, the

learners may be more able to effectively interrelate and integrate educational content and experiences, thus facilitating an awareness of problems and encouraging personal pursuit of solutions (Ferrington & Loge, 1992). The capability to regularly participate in such a scenario in the very near future is unlikely, but during the next decade it is predicted that a number of similar emerging technological capabilities will be available for distance education (Dede, 1991). However, other forms of text-based virtual environments are readily available now.

MUDs, MOOs, and MUSEs enable participants to interact in a virtual environment. Multi-User Dialog/Dimension/Dungeons (MUDs) are text-based virtual environments offering real-time, text-based interactivity for groups. A MUD Object Oriented (MOO) is a MUD which offers a more complex experience because it is founded on an object-oriented language rather than a text-based language. Multi-User Simulation Environments (MUSE) combine elements of Internet Relay Chat and role-playing games. Each person creates his or her own virtual reality, or can participate in existing scenarios. All three of these virtual environments provide opportunities for discussions free of preconceived notions about participants, as is often found in a face to face setting. They do, however, need monitoring by the teacher to assure the discussion remains appropriate to the task at hand.

Virtual environments open the classroom to explorations in a world heretofore inaccessible. Many designs of distance education are opening possibilities for new kinds of interactions through alternative arrangements of space, time, and resources for teachers and students. While many school districts are still exploring how to connect their computers to the information superhighway, others are attempting to use technology to restructure the way they go about education.

### Cyberthoughts

As previously mentioned, computers have been the topic for the majority of discussions about technology in the classroom. Now, as businesses are realizing the potential of combining computers with telecommunications to empower team performance over vast distances,

educators are feeling the need to explore and integrate the use of these powerful tools in their classrooms so their students will be better prepared for the demands of adult life. Yet, teachers are still struggling to integrate computers into their classrooms, let alone worrying about being connected to the information superhighway. The lack of teacher training in technology and its integration into the curriculum has limited its use. If teachers are going to use technology in different ways, they not only need skill-training workshops, but also discussions about the type of learning environment they expect to construct and training on how to implement these constructions.

The world is changing. Old and new paradigms seem to be on a collision course. Relationships between students and teachers will be challenged because the new technologies can provide access to information that once was controlled by the teacher. With increased access, teachers will not be able to compete with the capacity of new technology to provide information. They need to learn to channel its potential to support the learning in their classrooms. They need to be provided with places to discuss, learn, and experiment with new ideas and new technology. They need time to adjust to changes in their classrooms. No longer is the teacher the sole source of information dissemination. The harnessing and appropriate channeling of student's expanded access to information is falling directly on the teachers' shoulders, whether they want it or not.

As teachers are placed in technologically-mediated learning environments and expected to use innovative practices, they will require proper training and staff development. Staff development needs to become an essential component of the educational process in order to better prepare today's students for the high-tech world in which they will be living (Sherry, 1990). Teachers are attending workshops on the use of various forms of technology. Unfortunately, these are often one-shot workshops focused more on the manipulation of the tool rather than use of the tool to support students attainment of the learning goals and

objectives. To facilitate staff development, frameworks which support the design of varied learning environments need to be developed.

From fiber optic networks to the World Wide Web, the interactive nature of new distance learning technologies provides students and instructors with technologies that are intended to be flexible, explorative, and open to social uses and whose potentially rich sources of data will be readily available in response to the demands of the learners functioning within an open environment. Their availability for use in life contexts can substantially change the way we work, think, do, and learn.

To respond to the changing needs of students, distance education design should be focused on social interactions and communication that support a social, distributed, and situated construction of new knowledge. The development of constructivist-based distance learning environments can embody this design. The design will not occur simply because instructors have access to the new technology. Instructors must be introduced to the nuances of integrating new ways of constructing learning with the new more powerful distance settings to provide students with the tools necessary for effective participation in the 21st century.

Mehlinger (1996) created a succinct picture of the imminence of technology's impact:

If you believe that schools are part of the American culture, that the American culture is increasingly influenced by Information Age technology, and that teachers participate in the American culture as much as other Americans, then you cannot also believe that teachers will use the technology outside of school but fail to employ it in their classrooms. Technology will be used extensively in schools. That much is inevitable (p. 407).

Considering the nature of distance education, with students expected to shoulder more of the responsibility for learning, and the capacity of emerging technology, with its increased capacity to support learning, the marriage of constructivism and distance education seems a likely fit. As teachers embark on this trip into uncharted territories, it will be tempting to look

backward for familiar tools to assist in adapting to new environments. The intent of this book is to provide a look forward at methods and tools that better support new environments.

### Glossary

Construction Kits: packaged collections of content components for assembly and manipulation (e.g., Legos and authoring tools such as Hyperstudio).

Constructivism: body of learning theory that acknowledges the role prior knowledge plays in the construction of new knowledge.

Constructivist Learning Environments (CLEs): a place where learners may work together and support each other as they use a variety of tools and informational resources in their guided pursuit of learning goals and problem-solving activities. Settings intended to support and stimulate the learner, making ideas accessible, avenues apparent, mysteries inviting, and problems approachable.

Cyberspace: the electronic space created by computers connected together in networks like the Internet. In a broader sense, cyberspace has been used to mean the world of interconnected minds. The places that can be visited via a computer network that do not really have a physical existence, but they have some kind of existence; in the same way, the places and characters in literature and mythology, though they never exist "in real life," have an existence in the domain of the human collective consciousness.

Distance Education: teaching and learning situations in which all or some of the students and instructor(s) are geographically separated, and therefore, rely on electronic devices and print materials for creation of the learning environment.

Emerging Technology: high performance computing and communications technology that can vary instructional methods and media systematically according to the cognitive demands of learning tasks.

Information Superhighway: a worldwide fiber optic network that can simultaneously transmit voice, data, and video.

Learning Environment: a place where individuals can use available resources to make sense out of things and construct meaningful solutions to problems.

Phenomenaria: areas for presenting, observing, and manipulating phenomena that bring aspects of the world to the student for inspection and exploration (e.g., aquariums, SimCity, microworlds).

Scientific Concepts: concepts organized in a set of consistent, systematic relations resulting in a certain position in relation to other concepts, i.e., a place within a system of concepts.

Spontaneous Concepts: concepts that develop in the context of a person's everyday experiences.

Multi-User Simulation Environment (MUSE): a virtual environment that provides opportunities for multisite participants to take part in discussions under a veil of anonymity.

Multi-User Dialog/Dimension/Dungeons (MUD): text-based virtual environments offering real-time, text-based interactivity for groups.

MUD Object Oriented (MOO): a MUD which offers a more complex experience because it is founded on an object-oriented language rather than a text-based language. Multi-User Simulation Environments (MUSE) combine elements of Internet Relay Chat and role-playing games.

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## DEVELOPMENT OF CONSTRUCTIVIST-BASED DISTANCE LEARNING ENVIRONMENTS: A KNOWLEDGE BASE FOR TEACHERS

An article to be submitted to Educational Technology Research and Development

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In response to societal shifts, K-12 teachers are struggling to design effective learning environments. The advent of increased access to world-linking technology has increased the use of distance education to enrich and expand the learning landscape for students. A number of individuals have suggested that a relatively new body of learning theory, constructivism, supports technology-rich classrooms as a part of a vision of the 21st century. To support and facilitate teachers' responses to these changes in their classrooms, this project sought to identify a core of constructivist-based learning environment designs and experiences or elements necessary for their implementation in a distance education setting. A panel of very knowledgeable individuals in the areas of constructivism and technologically-mediated education participated in an electronic Delphi study. Findings indicated that teachers who wish to develop constructivist-based distance learning environments will need training in the creation of authentic, student-centered lessons. In these lessons, students take responsibility for establishing, carrying out, and evaluating their knowledge development and teachers take responsibility for creating, facilitating, and assessing the students' learning process.

### Introduction

Discussions about the appropriate role of technology in the learning process have increasingly stressed a body of learning theory called constructivism (see e.g., Duffy, Lowyck, & Jonassen, 1993; Jonassen, 1996; Wilson, 1996). Constructivism is a "body of theory" (Knuth & Cunningham, 1991, p. 163) about knowledge and learning; it describes both what "knowing" is and how one "comes to know" (Brooks & Brooks, 1994; Fosnot, 1996). A constructivist sees knowledge as "temporary, developmental, nonobjective, internally

constructed, and socially and culturally mediated” (Fosnot, 1996, p. ix). In the classroom, this translates into a definition of knowledge as an “adaptive function” rather than the “purpose of producing representations of an independent reality (p. 3). Students, in order to generate knowledge, are engaged in tasks that allow them to self-select learning paths. As students move along their learning paths, they attempt to make sense of new information and experiences by transforming and organizing encounters in relation to their own knowledge base while their teachers serve as learning facilitators. As much as possible, the learning environment replicates authentic and legitimate work, providing students with opportunities to learn in settings connected to the world outside school (Sheingold, 1991). The relevance of these settings is thought to provide motivation because the student perceives them as real, instead of memorizing inert bits of knowledge. The focus in a constructivist learning environment is on the construction of personal knowledge in a context similar to that in which the knowledge will be applied (Savery & Duffy, 1996).

When knowledge is being “constructed,” the tools to support that construction become important. Technology is one of the tools impacting society and, as such, education. As one looks towards the contexts that will evolve in the future, there is little doubt that technology will play a key role (Kimball & Sibley, 1997; Knuth & Hopey, 1997). One form of learning environment created through the use of technology is the distance education setting. Distance education can be defined as classroom learning where “students and teachers are separated by distance and sometimes by time” (Moore & Kearsley, 1996, p.1). Distance education technologies offer many opportunities to restructure the teaching - learning process. These changes include increased flexibility, interactivity, and access to a wide variety of resources for teachers and students. The placement of sophisticated technologies for distance education make sense only if updated curriculum can use them effectively. Using these technologies effectively requires a linking between educational needs and technological capabilities (Roblyer, Edwards, & Havriluk, 1996).

In the past, distance education was conceptualized as an industrialized form of education with instructional materials packaged for the purpose of delivering instruction to a remote learner (Keegan, 1986, p. 47). Today, high performance computing and communications capabilities, with their increased bandwidth, interactivity, and accessibility, are presenting numerous opportunities for students, teachers, and information to interactively mesh in the construction of knowledge at a distance. Innovative types of pedagogy enabled by these emerging media, messages, and experiences make possible a transformation of conventional distance education (i.e., replicating traditional delivery forms of education) into alternative instructional configurations (Dede, 1995a).

Methods used to optimize instruction by linking content and the communications characteristics of the medium are important issues under discussion (see e.g., Mehlinger, 1996; O'Neil, 1995; Sheingold, 1991). Too often, the potential of the technology for collaboration and interaction is ignored as one-way lectures are delivered to students in remote locations. Jonassen et al. (1995) believed that the most valuable classroom activity is the opportunity for "students to work together and interact together to build and become part of a community of scholars and practitioners" (p.7). They suggested that technology used in distance education should facilitate these learning processes rather than broadcast teacher-centered lectures and demonstrations. Johnson, Johnson, & Smith (1991) described a type of learning that fits well in this environment: active learning.

Active learning involves students in the knowledge construction process. Students engaged in active learning construct their own knowledge and understanding while teachers support, facilitate, and coach. Both students and teachers participate in the dynamic process of understanding and creating knowledge. Social support within the learning situation is viewed as important to the learning (Johnson, Johnson, & Smith, 1991). A body of learning theory that supports this vision of education as it is applied to distance education is constructivism.

Great time and effort have been spent discussing constructivism (see e.g., Duffy & Jonassen, 1992; Duffy, Lowyck, & Jonassen, 1993; Wilson, 1996) and distance education (see e.g., Willis, 1994; Portway & Lane, 1994). But little discussion has surrounded the knowledge teachers need to implement a constructivist-based distance education program. This study brought together an outstanding cadre of individuals in constructivism and technologically-mediated learning for the purpose of identifying the elements a teacher must have to responsively create, facilitate, and assess these learning environments. Professional development in technology applications, expected to be used to reform the learning environment, have seldom kept pace with a district's purchase and installation of technology (Hawkins & Macmillan, 1994). Attention needs to be shifted to staff development that combines instruction and technology to develop new learning conditions through new teaching practices (Roblyer et al., 1996). The intent of this paper is to identify teachers' training needs as they seek to create constructivist-based distance education.

### Changing Roles

Much has been written about the shift in society from the Industrial Age to the Information Age (Banathy, 1993; Reigeluth 1994; Toffler, 1990). Access to vast amounts of information via expanding and evolving technology (e.g., cable television, computer networks, the Internet, fiber optic networks, telephone, and satellite) has changed the roles of individuals both in education and business. Banathy (1993) displayed the discontinuity between the two eras as shown Table 1. The focus of production has shifted from one that is supported by machines to one that supported by an individual's ability to access and use information. Information access is extended through the use of technology. To prepare students to be effective in this changed environment, education needs to change from practices based on interpreting the past to practices where teachers and students work together to mutually shape knowledge (Banathy, 1993). Technology offers one of the mechanisms to meet this vision.

Table 1

General Characteristics of the Industrial and Information Ages

	Industrial Age	Information Age
Purpose and Mode	Processes organized around mechanical energy for material production	Processes organized around intellectual technology for information and knowledge development.
Power Base	Extension of our physical powers by machines.	Extension of our cognitive powers by high technology.
Technologies	Inventing, manufacturing, fabricating, engineering, etc.	Gathering organizing storing information; communicating, networking, and systems planning and design.
Principal Commodity	Energy, raw and processed materials, machines and manufactured products	Theoretical knowledge and information used to support innovation, design policy, and services.

Adapted from Banathy (1993).

Learning and Technology

As technologies that support new visions of schooling have become more available, distance education has had an increasingly prominent presence in discussions of educational change (Hawkins, 1991). Telecommunication networks are combining voice and audio transmissions with use of the information superhighway to provide channels of communication for teachers and students heretofore unavailable. A global picture shows that these computer and telecommunications technologies have the potential to propel distance learning to the forefront of the educational scene (Garrison, 1993).

As the field of education shifts from an instructional focus to a learning focus (Barr & Tagg, 1995), so, too, does distance education. This shift requires a redefinition of distance education, moving away from an industrialized model which focuses on production and delivery of instruction (Keegan, 1986), to a technological model which focuses on technology

as a mediator of the learning environment, providing communication and knowledge construction between students, teachers, and information (Dede, 1995a; Garrison, 1989).

Technologically-mediated interactive education (TMIL), a view representative of the redefinition of distance education, is presented by Dede (1991). He described TMIL as learning in which

- (a) a technological medium either interposes between direct person-to-person interaction or provides a shared environment that shapes the process of interpersonal communication;
- (b) the technology provides the tools and experiences that enhance the collective learning of the people involved, as well as their individual accomplishment;
- (c) the human participants' interaction is spontaneous (p.254).

Dede (1995b) reminded us that the introduction of telecommunications networks into the classroom does not instantly create learning. He posited that information technology is more like clothes than like fire. Fire is a wonderful technology because it can be operated (i.e., warms) without the user knowing anything about it. But to receive benefit from clothes, the clothes must be made a part of one's personal space, tailored to the needs of the individual. He added that new media should assist in classroom tailoring by expanding the tools available for teachers as they create distant learning environments. He concluded that the most significant influence on distance education will be the professional development of wise designers, educators, and learners.

### Technology Integration

There is little doubt that technology is impacting our nation's classrooms (Hadley & Sheingold, 1993). In the last decade, the use of telecommunications networks in the classroom has become a widespread component of numerous technology integration efforts, contributing to the broad-based agreement that telecommunications can enhance the range and scope of what students can learn in a classroom (Honey & Henriquez, 1993). Unfortunately, the introduction



of technology-based educational systems have lacked support through their implementation phase (Office of Technology Assessment, 1989; Albright & Graf, 1992). Many of the systems were either misused or remained unused, eventually finding their way to storerooms, leaving behind an attitude of disdain towards technology among both teachers and administrators. Closer examination of the problem finds that it was not the technology, per se, but the failure to plan for its use within the instructional context that was lacking (Albright & Graf, 1992).

In its 1989 report, Linking for Learning, the United States Office of Technology Assessment (OTA) noted that a mismatch between student needs and qualified teachers had driven many districts to adopt distance learning strategies and that the key to success in these programs was the teacher. It was reported that in order for teachers to be successful, new methods of student-teacher interactions needed to be adopted in these distant settings. Finally, it was concluded that "teachers must be trained if they are to use distance learning technology" (p.88), not only in the "technical aspects of the system, but also in the educational applications of the technology" (p. 95). Unfortunately, it was found that training opportunities remain limited. Similar findings were noted by Honey and Henriquez (1993) in their survey of 550 teachers who were active users of telecommunications, citing that telecommunications training was available at only 8 percent of their schools and 13 percent of their districts.

Included in the calls for change in education have been discussions about the body of learning theory, constructivism, and the role of telecommunications to create effective technologically mediated learning environments. A learning environment is a place where the learners can draw upon resources to make sense out of things and construct meaningful solutions to problems (Wilson, 1996). A technologically-mediated learning environment treats technology as a tool and intellectual partner to facilitate thinking and knowledge construction. The intent is to create enriched environments that support more effective educational practices (Hawkins, 1991). A constructivist-based learning environment focuses on: "(a) knowledge

construction, not reproduction; (b) conversation, not reception; (c) articulation, not repetition; (d) collaboration, not competition; and (d) reflection, not prescription" (Jonassen, 1996, p. 62). The creation of a learning environment that combines emerging technology and constructivist-based tenets can make use of these strategies in a technologically mediated learning environment.

To move beyond discussion and into implementation requires the focus be shifted to the those expected to carry out change, the teachers. Effective implementation consists of "alteration in curriculum material, instructional practices and behavior, and beliefs and understandings on the part of teachers" (Fullan & Hargreaves, 1992, p. 1). Changes in students' learning strategies, classroom configurations, and availability of the tools to support learning go hand-in-hand with a necessary component for implementation, teachers learning through staff development.

#### Staff Development

Staff development needs to become an essential component of the educational process in order to better prepare today's students for the high-tech world in which they will be living (Beaudoin, 1990; Sherry, 1990). Teachers must be given time to learn about the relationship between learning and the capabilities afforded by an innovation (Dede, 1991; National Education Commission on Time and Learning, 1994; OTA, 1989). The National Staff Development Council (1995) addressed this issue conclusively:

People must be able to attach personal meaning to new experiences before they can accept what the changes mean to themselves and the organization. Most innovations in schools entail changes in some aspects of educational beliefs, teaching behavior, and use of materials. Individuals must develop meaning in relation to all three. The multidimensional concept of change increases the complexity of planning and implementing effective staff development (p. 14).

Hord, Rutherford, Huling-Austin and Hall (1987) studied how schools might create successful change. Their conclusions about this process included the ideas that

- Change is a process and not an event. It occurs over a period of time, usually several years.
- Change is accomplished by individuals. Change affects people: their role is of the utmost importance.
- Change is best understood in operational terms. Those impacted by change will relate to change in terms of what it means to them or how it will affect their current classroom practice.
- The focus on facilitation should be on individuals, innovations, and the context.

The real meaning of change lies in its human, not its material, component.

The researchers also stated that the most important factor in all change is the support and assistance provided to make the change.

This project addressed the needs of teachers as they create constructivist-based distance learning environments. Change does not come easily. For many, this learning configuration is a change from what they have traditionally done. The simple identification of strategies or products necessary to support these learning environments is not enough. Teachers will need a knowledge base to draw from as they develop and implement their curriculum. A framework of knowledge to enable a teacher to implement constructivist-based learning within the distance education setting was the focus of this project. In other words, the project studied what teachers should know and be able to do to implement constructivist-based distance education. The framework can be used by educational institutions as they plan the process for assisting teachers in implementing active learning at a distance.

## Method

### Research Design

The purpose of this Delphi study was to have nationally recognized individuals identify instructional designs or experiences to be used in the creation of constructivist-based distance learning environments. In addition, the elements needed for their implementation and use by teachers were identified. In this study, the Delphi technique was used as a forecasting method in order to “identify new factors influencing the future state of a technological development or new needs which might be satisfied” (Twiss, 1992, p. 107). The Delphi study examined the needs of teachers who are expected to incorporate constructivist learning theory with emerging distance education learning environments. A panel of 13 knowledgeable individuals in the areas of constructivism and instructional technology completed the four-phase Delphi study. A profile of the panel is included in the section describing panel membership. A partial list of panel members is provided in Appendix E. The World Wide Web (WWW) was used as the primary vehicle for the development and iterations of the Delphi study. Three constructivist propositions, as identified by Savery and Duffy (1996, p. 135) guided the development of the study.

1. Understanding is in our interactions with the environment. Because understanding is a function of the interaction of the content, context, activity, and individual, a context was created to serve as a vehicle for the Delphi study. The School District #627 Instructional Support Project, a virtual school district, was established as a fictitious project intended to develop an outline of the teachers’ necessary knowledge to create, facilitate, and assess constructivist-based learning environments in schools without walls, a virtual school district.

2. Cognitive conflict or puzzlement is the stimulus for learning and determines the organization and nature of what is learned. The placement of the panel within the project context provided the purpose for the Delphi study. The identification of the knowledge and skills provided the stimulus for knowledge construction.

3. Knowledge evolves through social negotiation and through the evaluation of the viability of individual understandings. The social environment of the Delphi method and the use of the WWW provided the panel with opportunities to see and respond to each others' anonymous responses. The iterations of the Delphi study allowed the negotiation in the construction of the final product of the study.

Findings from the Delphi study were used to answer the following questions:

- What knowledge is perceived as important for teachers to learn in order to create, facilitate, and assess constructivist-based distance learning environments?
- How is the knowledge (as identified in the previous question) rated in importance to the creation, facilitation, and assessment of knowledge acquisition in constructivist-based distance learning environments?

#### Panel Membership

Panel members were strong conceptual leaders in the areas of constructivism, constructivist-based assessment, technologically-mediated education, instructional design, learning environment design, and distance and virtual learning environments. The primary areas of constructivism, constructivist-based assessment, instructional design, and distance learning did not offer enough participants for the Delphi, so the areas of expertise were expanded to include technologically-mediated education, learning environment design, and virtual learning environments. These areas were selected to provide broad coverage of the fields to be addressed in the Delphi study. A selection matrix was constructed including the headings of: (a) Recommendation; (b) Published 1; (c) Published 2; (d) Presentations. Consideration for project inclusion required that a panel member be represented in two of the areas. In addition, each person's expertise was identified so that a broad base was covered by panel members. Identification of panel members came from searches of the Association for Educational Communications and Technology (AECT) conference proceedings, ERIC, the review of Iowa State Universities library resources, and conversations with recognized leaders

in the fields. From these searches, 23 top leaders were identified. Fifteen people agreed to participate in the first and second phase of the Delphi study. Of those 15, 13 completed the third and fourth phases. The final Delphi study panel consisted of 3 females and 10 males. Fourteen of the original panel members were in the university setting and one was in private business. All panelists were located in the United States. The final 13 panel members were from 12 different states. Panel members are listed in Appendix E.

### Instrument

All instruments were available on the School District #627 Instructional Support Project World Wide Web (WWW) site. A previously expressed concern about formatting problems during an electronic mail-based Delphi study (Bell, 1992) and a concern about ease of replying, led the researcher to the use of the WWW for the project. The WWW was chosen because: (a) it could be designed to provide a simplified interactive environment thought to encourage input from the panel; (b) it provided a more standardized format for viewing the information presented on the pages; (c) it facilitated setting of the context and connections to support documents by its ability to hyperlink pages; (d) it offered the flexibility of adding follow-up iterations while still maintaining previous ones for the panel members' edification. The details for the WWW site are discussed elsewhere in this article.

A concern noted in the planning of this project was the chance that outsiders might respond to the Delphi instrument and confound the study. A WWW assessment response program, Classnet (Boysen & Van Gorp, 1996), was incorporated into the project to assure panel members' anonymity and reception of only authorized responses. Classnet required an alias before answers could be submitted, thus eliminating outside interference.

### Procedure

The Delphi technique is a forecasting and information-gathering procedure, which, instead of physically bringing people together, uses other communication channels for anonymous discussions. Originally the Delphi technique was used to make predictions about

the future, but it has since been used to identify problems, define needs, establish priorities, plan curriculum, and identify and evaluate solutions (see e.g., Billingsley, 1984; Borg & Gall, 1984; Linstone & Turoff, 1975; Volk, 1993). The Delphi technique can be used whenever a consensus is desired from persons who are knowledgeable about a particular topic or when a decision-maker is interested in having an informed group present all of the options and supporting evidence for consideration in the development of a document or policy (Martino, 1983; Linstone & Turoff, 1975; Twiss, 1992). The Delphi technique was selected for this research project to engage knowledgeable individuals from across the nation to come to consensus on constructivist-based distance education learning environment designs or experiences and the identification of necessary teacher preparation to implement the designs.

A variable which cannot be controlled when setting up a Delphi study is the number of phases, or rounds, that will be needed to reach consensus. Most Delphi studies try to maintain a three- to four-phase limit (Turoff, 1975). The construction of the questionnaire appears to have an impact on this dimension. Scriven (1991) warned that if the first questionnaire is constructed in a manner which overly constricts the input, the quality of the study will be reduced before it begins. A framework can be constructed for the panel based on the structure of the research and review of literature, but the knowledgeable input of the panel should also be solicited. This process was of particular importance in this study, as constructivists believe that "learning is an active process in which meaning is developed on the basis of experience" (Bednar, Cunningham, Duffy, & Perry, 1992, p. 91) with growth evolving from the sharing of multiple perspectives and cumulative experience. Therefore, rather than constraining the conversation by providing answers for which participants respond, a potentially real world context, the School District #627 Instructional Support Project, was provided where panel members could explore, reflect, and respond. The School District #627 Instructional Support Project scenario was explained to panel members as follows:

For the first time in its history, K-12 School District #627 is able to preplan all components for a student's educational experience . . . The results of the project will be used to guide inservice activities for the district's teachers . . . Over the last 3 years, the city served by School District #627 has been wired for interactivity with a fiber optic system called the Virtual Network (VN). As the city began planning for the VN, the school district began planning for their transition to a school district without walls--a virtual school district. The district has access to and the financial resources for use of any type of distance technology they choose. There are no limits on the resources (technological or otherwise) available; the only parameter is that the learning setting offer interactivity to its participants. After a series of meetings with educational stakeholders and learning consultants, the district has selected constructivism as the philosophical foundation for learning in the new classrooms (Herring, 1996).

The intent of the context was to frame the discussion, but leave it open to the areas of expertise of the panel members. The scenario was left broad enough to allow visioning for future technology (i.e., any type of distance technology) while clearly situating the discussion in a K-12 constructivist-based learning environment.

A majority of the communication was carried out via the computer, using email for management issues and the WWW for the Delphi study. Panel members' travel schedules or temporary lack of access to the Internet or a Web browser occasionally required a phase be mailed or emailed. Phase One of the Delphi study provided for the social negotiation of the design-guiding principles. Phase Two, based on panel members' comments, presented rewritten and reordered design-guiding principles and an instrument that asked panelists to provide design components or experiences and essential elements of teacher preparation that would exemplify the principle. The grounded theory strategy of the Constant Comparison method was used to analyze responses. Grounded theory is general methodology for developing or elaborating and modifying theory. Research using grounded theory methods



constantly redesigns and reintegrates theoretical notions as material is reviewed. In other words, the constant comparison of new data to previous data continues to influence the outcomes (Glaser & Straus, 1967). Table 2 presents a series of steps in the constant comparative method (Bogdan & Biklen, 1982) and their use to analyze and develop the Delphi study instrument.

Table 2

### Steps of the Constant Comparative Method

Steps of the Constant Comparative Method	Steps in the <u>Instructional Support Project</u> Delphi Study
1. Begin collecting data.	1. Request panel members response to principles used to guide the design of constructivist learning environments.
2. Look for key issues, recurrent events, or activities in the data that become categories of focus.	2. Develop Phase Two instrument out of information gained in Phase 1 iteration.
3. Collect data on incidents of the categories looking for diverse dimensions of each category.	3. Panel members provide designs, experiences, and elements to implement design-guiding principles.
4. Write about the categories, attempt to describe and account for all the data's incidents.	4. Categories are developed out of the principles.
5. Work with the data and emerging model to discover basic social processes and relationships.	5. Responses are analyzed, common themes and emerging patterns are identified. Results are distributed among the identified categories. Categories are reviewed for appropriateness based on the responses.
6. Engage in sampling, coding, and writing as the analysis focuses on the core categories.	6. Succeeding iterations identify the appropriate components for teacher training.

Open coding was used to guide the development of the instruments for Phase Two and Three responses. Open coding is a "process of breaking down, examining, comparing, conceptualizing, and categorizing data" (Strauss & Corbin, 1990). The final product of open coding (i.e., the final set of designs or experiences and their corresponding elements of implementation) is grounded in the joint constructions of the respondents. In the Grounded Theory method, the analytic process of open coding is used to identify and develop concepts in terms of their properties and dimensions. The procedures by which this analysis is accomplished are through asking questions about data and making comparisons for similarities

and differences between each incident, event, and other instances of phenomena (Strauss & Corbin, 1990). Events and incidents identified as similar are labeled and grouped to form categories (Strauss & Corbin). Thus, the final product is grounded in the individual responses of each panel member.

Guba and Lincoln (1989) suggested four criteria that the final product must meet to be considered grounded in the theory of the panel members' responses:

1. Fit: The categories and terms of the construction must account for data and information that the final instrument is presumed to encompass. In this project, all responses were analyzed, synthesized and parceled out between the identified categories.
2. Work: It must provide a level of understanding that is acceptable and credible to the respondents. For this project, each respondent had the opportunity to provide comment and input as the instrument was being developed.
3. Relevance: The final product must deal with the constructs, core problems, and processes that have emerged. During the Delphi study, panel members provided their input through the experiences, designs, and elements they suggested to implement each principle.
4. Modifiability: The construction must be open to change to accommodate new information. Through a dynamic process, panel members' responses were separated, coded, and combined under categories developed from each principle.

Phases Three and Four focused on identification of the framework of design-guiding principles and the design components or experiences and elements necessary for their implementation. Additional support pages were also added to the site as needed (i.e., explanation of the research process, hyperlinked definitions, explanation of the context, justification for changes in Phase One and Phase Two).

## The Delphi Study

### Phase One

For the first round, several pages were presented on the WWW site (see Appendix B). A graphic interface opened the site, allowing quick movement to other pages. An introductory page set the context for the Instructional Support Project while a Delphi/Definitions page offered clarification of the research process and terms. Finally, the Phase One instrument offered five design-guiding principles to support the creation of constructivist-based distance learning environments for review and comment by the panel. The principles were developed through an analysis of articles dealing with constructivism and through refinement discussions with Dr. Thomas Duffy, Indiana University, and Dr. Thomas Andre, Iowa State University. Email reminders were sent out twice during this phase.

### Phase Two

Phase Two WWW additions contained pages with panel members responses, justification for changes to the five principles, a definition of constructivism to further identify the design foundation, and the Phase Two instrument which contained rewritten and reordered design-guiding principles (see Appendix B). The design-guiding principles were revised to reflect panelists' input as well as input received after consultation with several individuals with expertise in constructivism. A general comment box was added at the request of several panel members in addition to the comment boxes provided for each question's response. The final five principles were:

1. Provide learning experiences which promote student reflexivity about both the content learned and the learning process in order to develop the student's self-awareness of the constructedness of knowledge and the student's self-control over the learning process.
2. Create dynamic, challenging, learning environments which are appropriate for the student's level of expertise, development, and culture and encourage, facilitate, and support student's taking ownership of the learning process.

3. Given a relatively defined domain of knowledge and learning goals, design authentic instruction situations that have relevance or, through teacher mediation, can become relevant to students and that actively engage students in the construction of transferable meaning.

4. Develop learning experiences which encourage the social negotiation of knowledge and provide learners with the opportunity to evaluate individual understandings of concepts and to expand individual and shared understandings.

5. Use dynamic, authentic assessment that is embedded in the instructional process to assess both student learning and the learning environment.

The panelists were asked to respond to the following questions pertaining to each principle:

1. Provide one example appropriate for School District #627 of a learning environment design component or experience that would exemplify this principle.

2. Identify the essential elements of teacher preparation needed by the District #627 teachers to implement the design or experience.

Responses were analyzed line-by-line using the open coding method (Strauss & Corbin, 1990), and common themes and emerging patterns were identified and consolidated into like statements where they were categorized. They were then placed into a Likert Scale format ranging from unimportant to very important. For example, "in a reflective journal, students record their learning goals and objectives" and "journal-keeping concurrent with projects, used to discuss issues and decisions surrounding the project" were two responses that were categorized under the design component or experience of "involving students in knowledge construction activities" within the teacher training element of "methods of documenting student's growing understanding (e.g., concept maps, journals, web sites)." The Likert scale was selected both for its scaling properties and for its ease of use (Scheibe, Skutsch, and Schofer, 1975). The Likert format, as well as comment boxes, were used for the rest of the phases. Email reminders were sent up to two times during this phase.

### Phase Three

In Phase Three, the panel members identified those components of the Delphi instrument they felt were most important to the design of the distance learning environments. Due to the instrument length, it was divided into five separate instruments which were hyperlinked to one another. A thumbnail overview was also created to give panelists a quick overview of the instruments. Panel members were asked to rate the importance of each design example and corresponding implementation elements on a Likert-type scale with ratings of unimportant, of little importance, moderately important, important, or very important. An example of a Delphi design component or experience is presented in Figure 1, and its companion teacher training element is presented in Figure 2.

The Delphi Statistical Tool (DST), a software program (Holden, 1992), was used to analyze the data. It computed the quartile deviation, interquartile range (consensus zone), and median for each item. It also created the questionnaires, emailed to panel members, showing consensus zones and personal previous phase responses.

### Phase Four

In Phase Four, panel members received three pieces of information via email: an identification number (e.g., #6) that was used to identify items needing individual panel member's response, the consensus zone (i.e., interquartile range), and the individual panel member's rating on the Phase Three questionnaire. Figure 2 is an example of the emailed questionnaire format which identified the panel member's response to each item. This questionnaire was compiled for each panel member by the DST and was sent for information purposes only. All responding was carried out on the WWW site.

A1. How important is the sharing of information and discussion about learning between students to the provision of learning experiences that promote student reflexivity about the content learned in order to develop the student's self-awareness of the constructedness of knowledge?					
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Unimportant	Of Little Importance	Moderately Important	Important	Very Important	< - Check One
Comments:					

A1.1. To implement sharing of information and discussion about learning between students, how important is it that a District #627 teacher receives preparation in creating supportive, positive environments for sharing and discussion?					
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Unimportant	Of Little Importance	Moderately Important	Important	Very Important	< - Check One
Comments:					

Figure 1. Phase Three Delphi Study Design-guiding Component or Experience Item (Item A1.). Phase Three Delphi Study Teacher Training Element (Item A1.1)

Because the intent of the Delphi technique is for the group to reach consensus, any response that fell outside of the zone of consensus (i.e., interquartile range) was asked to be re-evaluated and then either moved into the zone or a rationale for maintaining the answer was to be provided. In addition, items that showed consensus, but were more than two rating numbers wide, were asked to be reevaluated by all panel members. The consensus zones were identified on the web site Phase Four instruments along with individual panel members' comments provided during Phase Three. Comments offered in Phase Three were placed with the appropriate Phase Four question (see Figure 3). Inclusion of scores and comments have been shown as useful for respondents due to interest in the opinions of other panel members and a desire to move closer to the perceived consensus (Scheibe et al., 1975). Panel members

x	
1 2 3(4 5) —	A1. How important is the sharing of information and discussion about learning between students to the provision of learning experiences that promote student reflexivity about the content learned in order to develop the student's self-awareness of the constructedness of knowledge?

Figure 2. Phase Four Questionnaire Item: demonstrates panel member's rating and items' consensus zone.

whose responses fell outside the consensus zone were noted by their identification number (e.g., #1) as needing re-evaluation of their response. The overall results were represented on the WWW site in a format similar to Phase 3 except for the addition of the consensus zone and panel member's response identification.

A1. (#1, #4, #5) How important is the sharing of information and discussion about learning between students to the provision of learning experiences that promote student reflexivity about the content learned in order to develop the student's self-awareness of the constructedness of knowledge?

Phase 3 Comments:

# 13: This assumes that students are also learning the basic facts, concepts and principles needed so that they have something to reflect on

<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Unimportant	Of Little Importance	Moderately Important	Important	Very Important	< - Check One
1	2	3	4	5	(#1, #4, #5)

Comments:

Figure 3. Phase Four Delphi Study Item

Panel members could review Phase Three comments and then respond, where necessary, using the Likert Scale radio buttons and the comment boxes for each item. Thirteen panel members responded to the Phase Four instrument. The numerical ratings of the Phase Four questionnaire were again recorded in the Delphi Statistical Tool and the comments were compiled into a findings page on the WWW site. Two email reminders were sent during this phase.

#### Limitations

This was a very complex and very time consuming Delphi study (i.e., four phases; 95 items; one year). Phase One presented a set of five design-guiding principles for which panel members were requested to provide necessary comments on the general ideas presented in the



five statements to insure that no key point had been ignored or phrases misconstrued. Phase Two offered five rewritten and reordered principles based on panel members' responses and in consultation with several constructivists. Panelists suggested very in-depth descriptions of components or experiences and elements to be used for teacher implementation of the principles. Using a grounded theory method of comparative analysis (Glaser & Strauss, 1967), the responses were analyzed, categorized into components and elements, and put into a Likert Scale format. Phase Three consisted of the five design-guiding principles, 20 learning environment design components or experiences that exemplify a principle, and 75 essential elements of teacher preparation needed for design or experience implementation. This is many more items than is recommended (Martino, 1983), but the length was deemed necessary due to the need to address each principle's component or experience separately. Because of this need, there was some similarity in the elements, which also added to the length. Phase Four responses resulted in 17 of the 20 design components reaching high to moderate consensus at the important or very important level (see Tables 4.1 - 4.5). The Delphi study ended after the fourth phase.

The length of time for completion was impacted by technological problems, panel member's travel schedules, the size of the panel, and seasons of the year. The quality of the panel members was such that it was determined to be worth the wait for their responses. The World Wide Web was selected as the vehicle for the Delphi study because it was expected to facilitate the process. Unfortunately, some issues, such as the electronic system's faults that caused responses to be lost, served to detract from the process instead of facilitate it. The use of the WWW also contributed to the complexity of the Delphi study because each item had to contain the root (e.g., the component or experience) and the stem (e.g., the element), provided to remind panelists that items had a hierarchical connection. The following item shows the division between the root and the stem:

To implement the student modeling of and reflexivity on learning processes [the root], how important is it that a District #627 teacher receives preparation in the use of tools to construct student journals for documentation of and reflection on the learning process? [the stem].

Panelists were sometimes confused by this format and made statements such as “very convoluted” or “unnecessarily complex in its present form.”

Terminology seemed to be a problem. For example, the terms, “authenticity” or “authentic” were commented upon (e.g., “I would put more stress on ‘meaningfulness’ than on ‘authenticity’.”) as was the term “tools.” The term generated both positive and negative comments such as:

“... unless the teachers experienced applications of these tools in their own teacher preparation programs, they are unlikely to be able to implement them themselves.”

“Tools may help or provide ways to do things, but its the things themselves that are important”

“Tools change ... process is more important.”

Finally, the term “expert” seemed to cause quite a bit of controversy which appeared to come from an interpretation of the use of the “expert” processes:

“Students should be able to develop and share knowledge in ways that experts in the area might follow (the community of scholars analogy).”

“Many teachers lack the subject matter expertise necessary to be confident that they can mentor students engaged in authentic constructivist inquiry. They need access to expert models.”

“There is just too much of the top-down autocratic approach in the “expert” stuff here.”

### Results

It was decided at the conclusion of Phase Four that because 93% (i.e., 88 out of 95) of the items fell into the moderate to high consensus zone and 69% of the items had received important to very important ratings that the Delphi study would be concluded. In other words, 50% or more of the respondents agreed on the rating of the items. Items in the moderate to high

consensus zone and important to very important rating were said to have reached the target zone. Eighty-one percent (i.e., 17 out of 21) of the design components or experiences were in the target zone.

In determining consensus, several studies have used the quartile deviation which is one-half the distance between the 25th and 75th percentiles in a frequency distribution. Following Phase Four, using a formula defined by Scheibe et al. (1975), Faherty (1979), and Holden (1992), results showed 23% of the Delphi items reached high consensus (quartile deviation of  $\leq .5$ ), 65% of the items reached moderate consensus (quartile deviation of  $\leq .83$ ), and 11% reached low consensus (quartile deviations  $\geq .84$ ). Of the total components or experiences and elements, 69% of the items received moderate to high consensus on important to very important ratings. Table 3 shows the average consensus level and rating for each principles design components and elements.

Table 3

Average Consensus Level and Rating for Project #627's Design Guiding Principles

Principle	1	2	3	4	5
Component Consensus Level	.50	.54	.56	.43	.55
Element Consensus Level	.62	.61	.55	.56	.53
Component Rating	4.71	4.34	4.69	4.78	4.44
Element Rating	4.45	4.29	4.26	4.14	4.31

The results of the Delphi project are reported within Tables 4.1 - 4.7. The tables are divided by component or experience ratings based on consensus (quartile deviation) and level of importance (medians) with important (3.6 - 4.5) or very important (4.6 - 5.) ratings. Component or experience items are followed by an item number (e.g., A1) which corresponds with the number system found in Appendix C. the Delphi study results. The corresponding teacher training elements (following the same rating guidelines) for each component are included beneath the component. Several teacher training elements reached moderate to high consensus with an important to very important rating while their component or design received a lower rating. These "orphan" elements will be designated with a "\*" within Tables 4.1-4.5. and will contain both the root and the stem of the item and their Delphi instrument number.

#### Principle One

Principle One, which dealt with students reflecting on the content learning and the learning process, had 52% (16/31) of its items reach the target zone of high to moderate consensus at the important or very important. Four of its six design components or experiences reached the target zone. The average component consensus level was in the high consensus zone (.50) with the average rating of very important (4.71). The average element consensus level was in the moderate consensus zone (.62) with the average rating of important (4.45). Principle One responses are found in Table 4.1.

Within Table 4.1 items fit into several of the previously identified tenets of constructivism (Herring, 1997): (a) social negotiation of knowledge; (b) learner controlled; and (c) reflexivity. Panelists felt that students should be placed in distance education learning. Teachers also need to understand the use of techniques such as probing questions, task definition, and group interaction to assist students in their awareness of and control over the learning process.

Table 4.1

**Principle One: Moderate-High Consensus/Important - Very Important Components or Experiences with Important - Very Important Training Elements**

Provide learning experiences which promote student reflexivity about both the content learned and the learning process in order to develop the student's self-awareness of the constructedness of knowledge and the student's self-control over the learning process.

<b>Design Component or Experience</b>	<b>Quartile</b>		<b>Median</b>	
<b>• Teacher Training Element</b>	<b>Deviation</b>			
<b>Involving students in knowledge construction activities (A3)</b>	<b>.41</b>	<b>(H)</b>	<b>4.78</b>	<b>(VI)</b>
• Creating problem solving learning environments that require students to set goals and knowledge development strategies	.52	(M)	4.69	(VI)
• Methods of documenting student's growing understanding (e.g., concept maps, journals, web sites)	.57	(M)	4.25	(I)
• Strategies for probing students to think about their own thinking to help understand what they learned from an experience	.60	(M)	4.4	(I)
<b>Sharing of information and discussion about learning between students (A1)</b>	<b>.44</b>	<b>(H)</b>	<b>4.78</b>	<b>(VI)</b>
• Creating supportive, positive environments for sharing and discussion	.59	(M)	4.69	(VI)
• Tools used for the creation of small or large group technological discussion environments (e.g., computer conferencing, video conferencing, virtual conferencing)	.77	(M)	4.12	(I)
<b>Allowing student self-control over the learning process to the provision of learning experiences that promote student reflexivity about the learning process. (A6)</b>	<b>.52</b>	<b>(M)</b>	<b>4.69</b>	<b>(VI)</b>
• Creating learning environments that offer real world learning experiences that students are asked to interpret	.60	(M)	4.4	(I)
• Multiple approaches to knowledge construction and interpretation	.73	(M)	4.69	(VI)
• Creating learning environments that allow students to choose the angle from which they approach a topic they wish to study	.73	(M)	4.57	(VI)
• Strategies for task definition (e.g., rephrasing the problem into questions, recognition of multiple approaches)	.61	(M)	4.57	(VI)
<b>Student modeling of and reflexivity on the learning process (A4)</b>	<b>.57</b>	<b>(M)</b>	<b>4.25</b>	<b>(I)</b>
• Strategies and tools for students' construction of their own learning environments and explanations of why they did it that way				

Note: High consensus =  $\leq .50$ , Moderate Consensus = .54 - .83 quartile deviations. Very Important = 4.6 - 5. Important = 3.6 - 4.5 medians. n = 31.

Table 4.1 (continued)

Design Component or Experience	Quartile		Median	
• Teacher Training Element	Deviation			
• Use of tools that permit students to reflect on their constructions, compare their views to those of others, and modify their understandings accordingly	.57	(M)	4.25	(I)
* To implement use of "expert" modeling examples of learning processes, how important is it that a District #627 teacher receives preparation in modeling their own processes of reflexivity?	.45	(H)	4.4	(I)

### Principle Two

Principle Two dealt with the tenets of the (a) novice to expert learning continuum and its impact on the (b) student's ownership of the learning process. As identified within Table 4.2, this principle had the lowest overall component ratings with none rated as very important but with all three of its components rated as important. It placed the 92% (12/13) of its items in the target zone. The average component consensus level was moderate (.54); the average element consensus level was moderate (.61). The average component rating was moderate (4.34); the average element rating was also moderate (4.29). The principle contained the highest overall (i.e., consensus zone and importance rating) rated teacher training element, "serving as a guide/facilitator for students rather than as an expert." This element parallels the constructivist tenet of teachers serving as knowledge facilitators (Herring, 1997). The finding supports the importance of the teacher's role in helping students organize and complete their learning processes. An additional role included the provision of necessary guidance and scaffolding by teachers as students move toward the learning goals. Mentioned several times in regards to teacher training for learning facilitation, was the teacher's need for modeling and training of this process. "Teachers may benefit tremendously from mentoring and support groups, where they can discuss their problems and observe other teachers' approaches to those problems."

Table 4.2

**Principle Two: Moderate-High Consensus/Important - Very Important Components or Experiences with Important - Very Important Training Elements**

Create dynamic, challenging, learning environments which are appropriate for the student's level of expertise, development, and culture and encourage, facilitate, and support student's taking ownership of the learning process.

<b>Design Component or Experience</b>	<b>Quartile</b>		<b>Median</b>	
<b>• Teacher Training Element</b>	<b>Deviation</b>			
<b>Students' establishment of plans to pursue their corresponding problem (B3)</b>	<b>.47</b>	<b>(H)</b>	<b>4.31</b>	<b>(I)</b>
• Serving as a guide/facilitator for students rather than as an expert	.27	(H)	4.96	(VI)
• Guiding students to recognize their ability to carry out their research strategies	.80	(M)	4.33	(I)
• Many ways understanding can be acquired	.82	(M)	4.33	(I)
• Use of tools (e.g., e-mail and WWW) that allow the monitoring and facilitating of student progress	.82	(M)	3.67	(I)
<b>Use of problem or case based learning (B2)</b>	<b>.50</b>	<b>(H)</b>	<b>4.50</b>	<b>(I)</b>
• Receives analytical skill development (i.e., learning to break a complex situation into component parts, identify essential and non-essential elements of the problem solving situation)	.30	(H)	4.00	(I)
• Modeling and coaching support as they design and implement problems for the classroom	.52	(M)	4.69	(VI)
• Shaping the size of real world problems to adapt the issues involved to a level appropriate for student's capabilities	.70	(M)	4.38	(I)
<b>Strategies to analyze the student's level of expertise, development, and culture (B1)</b>	<b>.65</b>	<b>(M)</b>	<b>4.2</b>	<b>(I)</b>
• Methods of teacher directed- and student self- assessment for identification of entry level skills and knowledge	.67	(M)	3.92	(I)

Note: High consensus =  $\leq .50$ , Moderate Consensus = .54 - .83 quartile deviations. Very Important = 4.6 - 5. Important = 3.6 - 4.5 medians. n = 13.

A review of comments identified that a number of the panelists felt that terms targeted at the student's level of expertise, such as "entry level skills," were too closely related to behaviorist or ISD terminology. However, one of the panelists offered that "knowing the entry behaviors and characteristics of participants informs the teacher/administrator what scaffolding and cognitive technology are required to initiate and sustain the mutual inquiry metaphor." The panelists also acknowledged that teachers need the skills necessary to individualize the learning (e.g., providing numerous learning resources, ability to understanding student's needs, task analysis, and assistance in planning the learning process).

### Principle Three

Principle Three included the constructivist tenets of (a) situated or authentic learning, (b) engaging students in active or generative knowledge construction, and (c) the influence of prior knowledge on that construction (Herring, 1997). Table 4.3 shows that this principle had 67% of components or experiences and elements in the target zone. The component consensus level was moderate (.56); the element consensus level was also moderate (.55). The average component rating was very important (4.69; the average element rating was important (4.26).

Results showed that teachers' training to implement these components should include learning strategies that motivate students through the creation of not only authentic instructional situations, but also through building on the influence of the situation's aesthetics and the ability to arouse curiosity and challenge in the student. To create such environments, teachers need to be able to situate the issues in an interdisciplinary setting and not just in the content domain so that students can understand the societal "supersystems" within which the knowledge resides. Due to its ability to replicate "authentic" situations, this model can help students learn to make connections between what they already know and what they are doing and to understand the influence of their previous knowledge on their interpretations. It was also identified that teachers need to assist distance education students in learning to find and evaluate information in terms of quality and relevancy. They must also be able to guide students in the productive relating of new information to prior knowledge.

### Principle Four

Principle Four focused on the constructivist tenets (Herring, 1997) of the (a) connectedness of knowledge both in the domain and in society, (b) effect of cognitive conflict, and (c) social negotiation of meaning. In the high consensus/very important category, Table 4.4 identifies that panelists rated this principle with the largest number of design components or experiences and training elements (87%), only rating two items outside the target zone. This principle also had the highest average level of consensus on the design



Table 4.3

**Principle Three: Moderate-High Consensus/Important - Very Important Components or Experiences with Important - Very Important Training Elements**

Given a relatively defined domain of knowledge and learning goals, design authentic instruction situations that have relevance or, through teacher mediation, can become relevant to students and that actively engage students in the construction of transferable meaning.

<b>Design Component or Experience</b>	<b>Quartile</b>		<b>Median</b>	
• Teacher Training Element	Deviation			
<b>Student motivation (C2)</b>	<b>.41</b>	<b>(H)</b>	<b>4.78</b>	<b>(VI)</b>
• Understanding, from an instructional design perspective, the inculcating of fantasy, curiosity, challenge, beauty, and social recognition into learning experiences (c.f., the research by Malone and Lepper on motivation in technology-based learning environments)	.50	(H)	4.14	(I)
<b>Grounding of issues in the real world to the design of authentic instruction situations (C1)</b>	<b>.51</b>	<b>(M)</b>	<b>4.78</b>	<b>(VI)</b>
• Use of content domains in the broad societal context of super-systems (e.g., social systems, social issues) as the stimulus for learning not just knowledge of narrow content domains	.54	(M)	4.57	(VI)
• Skills and techniques necessary to develop a situation that requires students to create and manage a project that deals with the topic/subject at hand (e.g., civics class: run an election campaign -- or have them run for office)	.65	(M)	3.80	(I)
<b>Teacher mediation between the knowledge domain and the students (C3)</b>	<b>.75</b>	<b>(M)</b>	<b>4.50</b>	<b>(I)</b>
• Evaluating the quality and authenticity of resources	.52	(M)	4.69	(VI)
• Helping students make connections between what they are doing and what they already know	.57	(M)	4.25	(I)
• Tools and strategies for finding and using relevant resources in a virtual environment	.57	(M)	4.25	(I)
* To implement insuring that the learner practices what is essential for the transfer situation, how important is it that a District #627 teacher receives preparation in techniques for relating material across disciplines. (C4.2)	.50	(H)	4.14	(I)
* To implement insuring that the learner practices what is essential for the transfer situation, how important is it that a District #637 teacher receives preparation in techniques for working in interdisciplinary teams. (C4.1)	.65	(M)	3.60	(I)

Note: High consensus =  $\leq .50$ , Moderate Consensus = .54 - .83 quartile deviations. Very Important = 4.6 - 5, Important = 3.6 - 4.5 medians. n = 13

components or experiences at .43; the elements' consensus level was moderate at .56.

Responses reflected the importance of training teachers to deal with the impact of an individual's encounters with others during the knowledge construction process, thereby allowing the individual to compare and contrast perceptions and offering the opportunity to evaluate and deepen personal learning structures. On this topic one panelist commented, "Constructivists see differences as riches and sharing of alternative points of view as essential to the process of reaching the constructivist form of ephemeral 'truth,' opinion based on consensus validation." The ability to ask and teach the use of probing questions, to listen, and to maintain discussions in a nonthreatening manner were all suggested as alternative strategies. Several panelists suggested that though the term collaboration is mentioned, it should be remembered that it is not the only strategy available to support "self-directed and cooperative-group learning."

#### Principle Five

Principle Five identified the need for authentic assessment as an integral part of the learning process and representative of the learning goals. As shown within Table 4.5, 71% of its items placed in the target zone with the components and elements both averaging moderate consensus (.55/.53). Both component's and element's averages fell into the important range (4.44/4.31). This principle had the second highest rated item (.33/4.85) in the Delphi study. The item identified the teachers' need to construct and implement performance assessments.

To accomplish the use of authentic assessment in the learning environment, results show that distance educators will need training in developing partnerships with students to create acceptable criteria or rubrics for performance assessment in a variety of ways that demonstrate learning. Several strategies were mentioned for authentic assessment but one panelist suggested, "There are many other forms of authentic assessment, and one's choice depends on many different factors." Another suggested that "we shouldn't neglect other kinds of assessment that give information about learning we hadn't planned for . . . goal-based

Table 4.4

**Principle Four : Moderate-High Consensus/Important - Very Important Components or Experiences with Important - Very Important Training Elements**

Develop learning experiences which encourage the social negotiation of knowledge and provide learners with the opportunity to evaluate individual understandings of concepts and to expand individual and shared understandings.

<b>Design Component or Experience</b>	<b>Quartile</b>			
<b>• Teacher Training Element</b>	<b>Deviation</b>		<b>Median</b>	
<b>Collaboration and interaction in a disciplined way that leads to sustained inquiry (D2)</b>	<b>.41</b>	<b>(H)</b>	<b>4.78</b>	<b>(VI)</b>
• Modeling for students how one arrives at collective criteria for judging the worth of various ideas and approaches	.45	(H)	3.81	(I)
• Use of collaborative projects to develop habits of good teamwork and clear communication	.54	(M)	4.42	(I)
• Development of questioning strategies to elicit student's rationale and evidence	.57	(M)	3.75	(I)
• Strategies for processing ongoing discourse to raise other ways ideas might be conceptualized	.61	(M)	3.75	(I)
<b>Embedding of problem solving in a social framework in which learners are inevitably exposed to multiple perspectives and a spectrum of individual problem solving strategies (D1)</b>	<b>.44</b>	<b>(H)</b>	<b>4.78</b>	<b>(VI)</b>
• Skills of negotiation, conflict resolution, and mediation	.51	(M)	4.78	(VI)
• Use of tools (e.g., Lotus Notes) that support student posting and feedback	.51	(M)	3.71	(I)
• Creating learning environments that allow students to compare individual problem solution strategies	.54	(M)	4.57	(VI)
• Strategies to assist students in expressing and defending ideas without becoming threatened	.54	(M)	4.57	(VI)
• Understanding and use of ideas from situated cognition	.54	(M)	4.42	(I)
• Understanding and application of Vygotskian principles	.59	(M)	3.69	(I)
• Development of tasks that require students at different sites to provide feedback and assistance to one another	.80	(M)	4.12	(I)

Note: High consensus =  $\leq .50$ , Moderate Consensus = .54 - .83 quartile deviations. Very Important = 4.6 - 5, Important = 3.6 - 4.5 medians. n = 15.

versus open assessment." One method that was identified as relatively important to the process was the use of portfolios to document learning. However, several panelists expressed concern about the time and energy this and other forms of authentic assessment take out of the day. Addressing a larger issue, another stated that "many participants, new to 'student-centered learning environments,' must go through a transformation in attitude on their way to accepting

Table 4.5

**Principle Five: Moderate-High Consensus/Important - Very Important Components or Experiences with Important - Very Important Training Elements**

Use dynamic, authentic assessment that is embedded in the instructional process to assess both student learning and the learning environment.

<b>Design Component or Experience</b>	<b>Quartile</b>		<b>Median</b>	
<b>• Teacher Training Element</b>	<b>Deviation</b>			
<b>Critiques of personal, classmember, or group work (E3)</b>	<b>.41</b>	<b>(H)</b>	<b>4.22</b>	<b>(I)</b>
• Constructing and implementing performance assessments	.33	(H)	4.85	(VI)
• Methods of providing honest, informed, and constructive criticism of thinking and argumentation	.54	(M)	4.57	(VI)
<b>Student and instructor negotiation of performance criteria or rubrics based on the learning goals and objectives (E1)</b>	<b>.52</b>	<b>(M)</b>	<b>4.69</b>	<b>(VI)</b>
• Identifying acceptable performance criteria or rubrics and remaining open to accepting student criteria they had not thought of originally	.47	(H)	4.69	(VI)
• Various methods and means for demonstrating the acquisition of relevant skills and knowledge	.54	(M)	4.57	(VI)
• Maintaining an overall assessment system that includes a balanced set of components (i.e., small-group and individualized; authentic and externally imposed; benchmark and routing; formal and informal; product and process; portfolios and skills demonstrations; embedded in instruction and tacked on)	.73	(M)	4.57	(VI)
• Understanding the concept of systemic validity (cf. Frederiksen & Collins, 1989) which recognizes that the evaluation process signals to teachers and students what kinds of teaching and learning activities they are expected to carry out	.73	(M)	4.57	(VI)
• Inferring understanding from students' *talk* about what they know and did	.51	(M)	3.71	(I)
<b>Understanding a wide range of skill areas, plans, and products (E6)</b>	<b>.62</b>	<b>(M)</b>	<b>4.50</b>	<b>(I)</b>
• Observing and understanding what students do and say while working in the environment	.51	(M)	4.29	(I)
<b>Portfolios (E2)</b>	<b>.65</b>	<b>(M)</b>	<b>4.20</b>	<b>(I)</b>
• Use of portfolios to assess learning (e.g., significance of goals, effort, productive plans, depth of reflection)	.47	(H)	4.31	(I)
• Use of tools for portfolio maintenance that document the learning	.51	(M)	3.71	(I)

Note: High consensus =  $\leq .50$ , Moderate Consensus = .54 - .83 quartile deviations. Very Important = 4.6 - 5, Important = 3.6 - 4.5 medians. n = 21.

Table 4.5 (continued)

Design Component or Experience • Teacher Training Element	Quartile Deviation	Median
* To implement the use of tools, how important is it that a District #627 receives training in tools that can help manage the complexity of data handling and management found in authentic assessment. (E5.1)	.54 (M)	3.58 (I)

increased responsibility for their own learning.” This suggestion is a key to the adoption of any of the design-guiding principles.

#### Moderate-High Consensus/Moderately Important Items

A number of items fell outside of the identified target zone of moderate to high consensus and important or very important rating. These are presented within Tables 4.6 and 4.7, along with a discussion about their placement. The design components or experiences and training elements are presented with their roots and stems since they are no longer situated in hierarchical order.

Table 4.6 contains all high to moderate consensus items rated as moderately important by the panelists. The items in the table contain both the root and the stem of the component or the element because they are divided at the principle level. Fourteen percent of the components (i.e., 3/21) are found in Table 4.6. Twenty percent of the elements (i.e., 15/75) were also located in the table.

Forty-seven percent of the items within the table contained the term “tools.” Comments made about the rating of these items included:

“... tools may help but they are not the core value--they can extend, enhance, etc.--but best emphasize the core value and the multitude of ways to support it vs. shifting to tools quickly.”

“The environment keeps changing and it is important for students to understand process rather than specific steps.”

“Tools change....process is important.”

“Tools are useful but only if the teacher has the purpose and basic process of facilitation clearly in mind. Use of the tool is not the top priority.”

Twenty-nine percent of the items contained the term “expert.” A number of panel members commented on the use of “expert” processes:

“...we don’t want students to see any particular “expert’s” approach as a “one size fits all” situation.”

“Though I would argue that teachers are rarely modeling truly expert processes—they model a way of thinking or approaching something that is, often by design, confounded by an explicit goal to guide through the process rather than model their own processes.”

Other panelists commented on the structure of items such as the element listed under Principle Two:

“Very convoluted. Are you going to know what this all means?”

“Not clear on the meaning”

Many of the items listed in Chart 4.6 mention the terms expert (29%) or tools (47%). These terms are found in both the Moderately Important ratings and also the Of Little Importance and Unimportant ratings found in the low consensus or Of Little Importance to unimportant rated items.

#### Low Consensus or Of Little Importance to Unimportant Rated Items

Table 4.7 contains all items that fell into the low consensus zone receiving ( $\geq .83$ ) or that received a Of Little Importance or unimportant average rating from the panelists. The items within the table contain both the root and the stem of the component or the element because they are divided by principle level. Eleven percent (i.e., 10/95) of all the items are found within this table. The term “expert” is found in the only component listed on the chart. “Expert” is

Table 4.6

**Moderate-High Consensus/Moderately Important Components or Experiences or Moderately Important Training Elements**

Design Component or Experience or -Teacher Training Element	Quartile Deviation		Median	
<b><u>Principle One</u></b>				
-How important are "expert" modeling examples of the learning process to the provision of learning experiences that promote student reflexivity about the learning process that promote student self-awareness of the constructedness of knowledge? (A5)	.69	(M)	3.25	(MI)
-To implement student's self-control over the learning process, how important is it that a District #627 teacher receives preparation in tools to support students' documentation of their learning?	.32	(H)	3.15	(MI)
-To implement use of "expert" modeling examples of learning processes, how important is it that a District #627 teacher receives preparation in tools that support the viewing of and interaction with experts engaged in formulating the problem, developing alternative solutions, and deciding which solution to use?	.45	(H)	3.19	(MI)
-To implement the involvement of students in knowledge construction activities, how important is it that a District #627 teacher receives preparation in the use of electronic student journals to record strategies used to achieve learning goals?	.45	(H)	3.19	(MI)
-To implement the student modeling of and reflexivity on learning processes, how important is it that a District #627 teacher receives preparation in the use of tools to construct student journals for documentation of and reflection on the learning process?	.50	(H)	3.14	(MI)
-To implement student's self-control over the learning process, how important is it that a District #627 teacher receives preparation in the use of technological tools that allow students to arrange and rearrange their knowledge construction in multiple ways?	.54	(M)	3.42	(MI)
-To implement use of "expert" modeling of learning processes, how important is it that a District #627 teacher receives preparation in analyzing expert interactions to discuss expert approaches to problem solving, reflection, and metacognition?	.60	(M)	3.08	(MI)
- To implement modeling of knowledge development and structures, how important is it that a District #627 teacher receives preparation in strategies for analyzing expert interactions to discuss the knowledge and skills experts use?	.61	(M)	3.25	(MI)

**Note:** High consensus =  $\leq .50$ , Moderate Consensus = .54 - .83 quartile deviations. Moderately Important = 2.6 - 3.5 medians.

Table 4.6 (continued)

Design Component or Experience or -Teacher Training Element	Quartile Deviation	Median
-To implement modeling of knowledge development and structures, how important is it that a District #627 teacher receives preparation in skills necessary to create remote apprenticeship/mentoring environments?	.65 (M)	3.40 (M)
-To implement modeling of knowledge development and structures, how important is it that a District #627 teacher receives preparation in creating experiences where discipline experts model multiple knowledge structures and expertise (e.g., listserv discussions, computer conferences, or video conferencing)?	.67 (M)	3.50 (M)
-To implement sharing of information and discussion about learning between students, how important is it that a District #627 teacher receives preparation in the tools used for electronic transmittal of information about knowledge construction (e.g., email, listserv, WWW, or FTP)?	.73 (M)	3.31 (M)
<b>Principle Two</b>		
-To implement strategies to analyze the student's level, how important is it that a District #627 teacher receives preparation on creating opportunities for teachers reflection and documentation of student needs (e.g., participation on teaching teams)?	.50 (H)	3.5 (M)
<b>Principle Three</b>		
-How important is insuring that the learner practices what is essential for the transfer situation to the design of authentic instruction situations that actively engage students in the construction of transferable meaning? (C4)	.77 (M)	3.42 (M)
-To implement insuring that the learner practices what is essential for the transfer situation, how important is it that a District #627 teacher receives preparation in the use of tools in the virtual environment necessary to monitor and nourish the interaction among students?	.56 (M)	3.29 (M)
<b>Principle Four</b>		
-To implement the use of collaboration and interaction, how important is it that a District #627 teacher receives preparation in the tools that may be used to facilitate group problem solving (e.g., collaborative software like Apple's "Co-Learning" System, concept mapping software like Inspiration, virtual environment software like Netscape)?	.73 (M)	3.31 (M)
<b>Principle Five</b>		
-How important are the use of tools to the use of dynamic, authentic assessment that is embedded in the instructional process to assess student learning? (E5)	.61 (M)	3.43 (M)
-To implement the use of tools, how important is it that a District #627 teacher receives training in programs that provide the teacher with an accurate reading on how students are approaching a problem in order to discuss strategies?	.41 (H)	3.22 (M)



Table 4.6 (continued)

Design Component or Experience or -Teacher Training Element	Quartile Deviation	Median
-To implement teachers obtaining an accurate reading on how students are approaching a problem, how important is it that a District #627 teacher receives preparation in methods that require student's summarization of perceptions on the effectiveness of the decisions made through the review of outcomes derived from the decisions?	.48 (H)	3.19 (M)

again found in the final item. The approach to the term was different than in previous principles: "access to 'experts' may be problematic, especially as the 'experts' begin to get swamped with requests from school teachers and students." Several comments identified wording as a problem. "... smacks of educationese" or, "... don't understand this one."

Others felt that wording was, at times, open to misinterpretation or was too restricting:

"I think the way this is written is more of a problem than the actual, or possible, intent. ... wording of this statement comes not from constructivist/reflective practice but from behavioral and information processing theories."

"It's important not to make anything too much like a recipe....which is what this sounds like."

"Way too specific an instance--it may be useful as one of many, but it assumes too much validity as a single approach."

Finally, some items were seen as knowledge that most teachers already should have acquired, so it was not necessary to re-teach them.

"Although I think its important that teachers DO this, I'm not sure how much preparation it truly requires."

Table 4.7

Low Consensus Delphi Design Components or Experiences and Teacher Training Elements or  
Rated as Of Little Unimportance or Unimportant.

<b>Design Component or Experience or -Teacher Training Element</b>	<b>Quartile Deviation</b>	<b>Median</b>
<b><u>Principle One</u></b>		
<b>-How important is expert modeling of knowledge development and structures to the provision of learning experiences that promote student reflexivity about the content learned in order to develop the student's self-awareness of the constructedness of knowledge (A2)</b>	.95 (L)	4.25 (I)
-To implement the involvement of students in knowledge construction activities, how important is it that a District #627 teacher receives preparation in creating learning environments that allow student's to construct personal learning environments focused on the concepts and principles learned? (A3.6)	.92 (L)	4.50 (I)
-To implement the involvement of students in knowledge construction activities, how important is it that a District #627 teacher receives preparation in use of activities such as compare/contrast, list generation, developing procedures (c.f., Sherry and Tngg, most recent EdTech issue)? (A3.4)	.97 (L)	3.6 (I)
-To implement student's self-control over the learning process, how important is it that a District #627 teacher receives preparation in strategies used to survey a student's efforts and quickly identify deficiencies in the learning strategies? (A6.4)	1.05 (L)	3.67 (I)
<b><u>Principle Two</u></b>		
-To implement strategies to analyze the student's level, how important is it that a District #627 teacher receives preparation in methods of soliciting student ideas, goals, strategies or performance criteria? (B1.3)	.86 (L)	4.57 (I)
<b><u>Principle Three</u></b>		
-To implement the grounding of issues in the real world, how important is it that a District #627 teacher receives preparation in the use of a skill by activity grid that identifies where formal concepts and everyday contexts intersect (used during planning to heighten awareness of teachers as to the nature of the connections with formal curriculum and to illustrate to parents, teachers, etc. how the activity reinforces, extends, etc., the school's curriculum [i.e., ward off the cruties])? (C1.2)	.61 (M)	2.43 (OLI)

Note: Items in bold are design components or experiences. Items not bolded are teacher training elements. Low consensus =  $\geq .83$ ; Of Little Importance rating = 1.6 - 2.5; Unimportant Rating = 1 - 1.5

Table 4.7 (continued)

Design Component or Experience or -Teacher Training Element	Quartile Deviation		Median	
-To implement the grounding of issues in the real world, how important is it that a District #627 teacher receives preparation in creating simple cases that closely represent a real-world task (e.g., Reigeluth's simplifying conditions method)? (C1.3)	1.06	(L)	3.38	(MI)
<b>Principle Four</b>				
-To implement the use of collaboration and interaction, how important is it that a District #627 teacher select and buy into a model(s) of collaboration, use it until it becomes automatic, and then teach it to the students to provide clear directions about how to do these things? (D2.1)	.81	(M)	2.62	(OLI)
<b>Principle Five</b>				
-To implement the use of critiques of personal, classmember, or group work, how important is it that a District #627 teacher receives preparation in the use of experts to provide feedback as to the clarity of the position presented and recommend other resources to assist in further understanding of the problem/issue being studied? (E3.2)	.57	(M)	2.92	(OLI)
- How important is it that a District #627 teacher receives preparation in developing a "performance technologists' view," i.e., a broad view of all factors affecting learning including physical environment, communication, group structure and process, motivation, prior knowledge and experience, etc.? (E6.1)	.87	(L)	3.67	(MI)

### Discussion and Implications

Results from all four rounds of this study provide those charged with training teachers a body of methods and strategies that can serve as the foundation for creating constructivist-based distance education. Constructivism can provide theoretical bases for exciting and effective distance learning environments (Jonassen et al, 1995). Results from the first two phases of the Delphi study provided a comprehensive instrument that was grounded in the responses of an nationally recognized panel. Phases Three and Four responses identified the panels' consensus and rating of importance on the design components or experience and their requisite teacher training elements. Eighty-five out of the ninety-five instrument items fell into the moderate to high consensus zone, verifying that the panel was consistent in their thinking

about the items. Seventy-seven of the ninety-five items reached moderate to high consensus with an important or very important rating demonstrating the strength of the study's findings.

Five training threads consistently identified as important or very important to the training of teachers in order to enable the design of constructivist-based distance learning environments included:

- Learning guide or facilitator roles for teachers
- Training needs of students to implement learning strategies
- Embedding of assessment within the learning process
- Creation and facilitation of problem-based learning
- Multiple approaches to knowledge development

For a synthesis of the specific training elements associated with the five training threads, see Appendix D. It is strongly suggested that strategies for these five items be incorporated into ongoing staff development. The intent of this project was to identify those necessary teacher training elements for the design and implementation of constructivist-based distance learning environments. These findings will assist staff developers and teachers who are charged with constructivist-based distance education's design and implementation.

In 1995, Jonassen et al. published the article, Constructivism and Computer-Mediated Communication in Distance Education. The authors posit that constructivist-based distance learning environments "should emerge from authentic tasks, engage the learners in meaningful, problem-based thinking, and require negotiation of meaning and reflection on what has been learned . . . [and] assessment methods that reflect the constructivist methods embedded in the learning environment" (p. 21). The results from this Delphi study expand these ideas. A review of the Delphi study found the three threads of problem based learning, multiple approaches to knowledge development, and embedding of assessment within the learning process were consistent with Jonassen et al.'s suggestions. Missing from their discussion was identification

of the teachers' roles when acting in a learning guide or facilitator role. This is indicative of writings on educational innovations, where the knowledge base needed by the teacher for implementation is not addressed. The training needs of students to implement their learning strategies was also left out of Jonassen et al.'s. discussion. Just as teachers will need training to function effectively in these learning environments, so too will students. Planning for staff development should also include information on similar student training needs so they, too, can function effectively in the learning environment.

Perhaps the most surprising outcome of this investigation was the secondary role of technological tools in the process. Many distance education training sessions have centered around issues such as time management, classroom management, instructor presence, and presentation issues. The results show that the training should center on the instructional issues first, the operational issues, second.

While the Delphi technique does focus on consensus items, it is not expected to reach a final decision on the identified topic (Billingsley, 1974; Turoff, 1975). The lack of an important or very important rating for items leaves it up to the individual planner to use the information to determine whether or not to include the item. During this project's Delphi study, the term "context" was often mentioned by panelists. Context could impact a decision to include one of these items or not. If the context of the learning appears to support its use, then it can be included in the teachers' staff development experience.

The findings offer guidance not only for curriculum in the classroom but also for continuous staff development. The challenge now is to integrate the findings into school districts' staff development activities. While the district provides the overall vision (i.e., constructivist-based distance education), the staff developer is charged with the responsibility of bringing that vision to the individual faculty needs within buildings. The key will be to create staff development training that will be ongoing and immerse teachers in a constructivist learning process.

In reviewing the design components or experiences and the elements necessary for their implementation, it is evident that they can be applied to most classrooms and staff development programs. The extent of items found to be important by the panel members can not be addressed in a singular training session. If any change is to occur, teachers will need the training, time, and support to develop and implement curriculum grounded in constructivist theory.

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APPENDIX A  
CONSTRUCTIVISM ARTICLE ANALYSIS

	Goal Oriented	Generative Knowledge Construction	Cognitive Conflict	Prior Experience	Situated or authentic learning and instruction	Social Negotiation of Meaning	Learner Centered	Novice to Expert Continuum	Teacher as Facilitator	Connected-ness of Knowledge	Reflectivity
Brooks & Brooks (1993)			♦	♦	♦	♦	♦				
Cognition & Technology Group (1991)	♦	♦	♦	♦	♦	♦		♦	♦	♦	
Cunningham, Duffy, & Knuth (1993)		♦		♦	♦	♦		♦	♦		♦
Savery & Duffy (1994)	♦	♦	♦	♦	♦	♦	♦			♦	
Duffy, Kremer, & Savery (1993)	♦	♦		♦	♦	♦	♦				
Forman & Putall (1988)			♦	♦			♦				♦
Fosnot (1992)			♦	♦		♦		♦		♦	
Jonassen, Mayes, McAleese (1991)		♦		♦	♦	♦	♦	♦			♦
Marra & Jonassen (1993)		♦		♦	♦	♦	♦				♦
Lebow (1993)		♦			♦	♦	♦				♦
Prawal (1992)	♦		♦	♦	♦	♦		♦	♦		
Strommen & Lincoln (1992)		♦		♦		♦	♦		♦		♦
Winn (1991)			♦	♦		♦		♦	♦	♦	♦

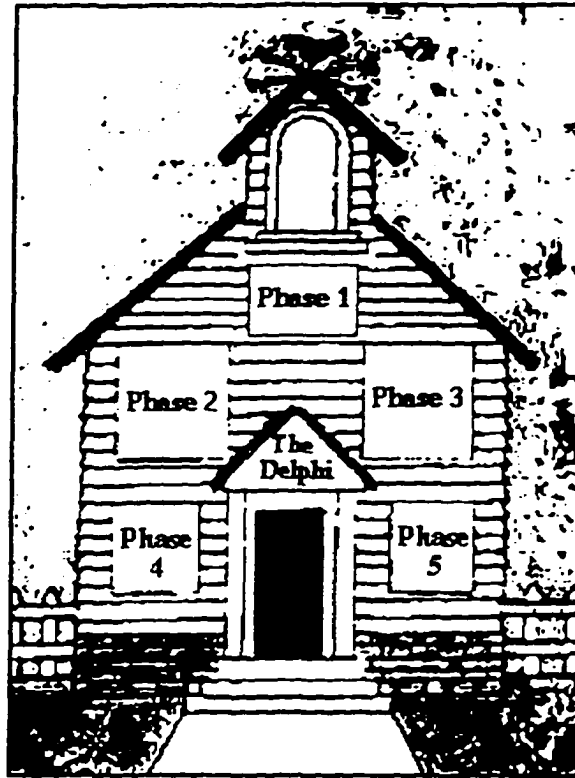
APPENDIX B

SCHOOL DISTRICT #627 INSTRUCTIONAL SUPPORT PROJECT  
WORLD WIDE WEB SITE

APPENDIX B1

INTRODUCTORY MATERIALS

## School District #627 Instructional Support Project




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Introduction Delphi/Definitions Constructivism
Phase 1Phase 1 ResponsesPhase 2Phase 2 ResponsesPhase 3Phase 4 Instrument 1 Phase 4 Instrument 2



The following scenario is presented as the simulated context for the ultimate identification of the knowledge that is important for K-12 teachers to learn to create, facilitate, and assess constructivist based, interactive, K-12, student-centered distance learning environments. Please review the scenario before beginning Phase 1 of the project.

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### School District #627 Instructional Support Project

To: Instructional Support Project Panel Members  
From: Instructional Support Project Director

Thank you for agreeing to participate in this very important educational experience. For the first time in its history, K-12 School District #627 is able to preplan all components for a student's educational experience. You have been selected to join a panel of fellow specialists in the areas of constructivism and design of technologically mediated learning environments to project what is required of teachers to design and implement constructivist-based distance education. Your contributions are considered very important to the success of the project. The results of the project will be used to inservice the District #627 teachers on the development of constructivist based distance learning courses and classrooms.

#### The Setting

Over the last 3 years, the city served by School District #627 has been wired for interactivity with a fiber optic system called the Virtual Network (VN). As the city began planning for the VN, the school district began planning for their transition to a school district without walls—a virtual school district.

The district has access to and the financial resources for use of any type of distance technology they choose. There are no limits on the resources (technological or otherwise) available; the only parameter is that the learning setting offer interactivity to its participants. After a series of meetings with educational stakeholders and learning consultants, the district has selected constructivism as the philosophical foundation for learning in the new classrooms.

#### Project Access

Each phase of the project can be accessed through the School District #627 home page. The phase "windows" in the schoolhouse will be activated as the project unfolds. Confidentiality during the project has been ensured through the use of alias'. Please type in your alias at the start of each phase.

Via electronic mail, you will receive notification of the result of each phase and the availability of the next phase. A completion date will be given for each phase; please notify the project coordinator if you are unable to meet the date. The project coordinator can be contacted at any time should you have comments, questions, or concerns at [mherring@iastate.edu](mailto:mherring@iastate.edu).

For an explanation of the Delphi technique planned for this project, go to the [Delphi](#) page.

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[Return to Homepage](#)    [Delphi](#)    [Phase 1](#)

## Delphi/Definitions

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### The Delphi Technique

The Delphi technique is a widely used forecasting and information-gathering process, which, instead of physically bringing people together, uses other communication channels for anonymous discussions. It is essentially a method for achieving a structured anonymous interaction between carefully selected authorities through the use of a questionnaire and controlled feedback. The rationale for using a structured process is that the probability of the results being sufficiently accurate for making good decisions will be improved (Twiss, 1992).

The Delphi is based solely on knowledgeable opinion. The Delphi can be used whenever a consensus is desired from knowledgeable individuals about a particular topic or when a decisionmaker is interested in having an informed group present all the options and supporting evidence for consideration in the development of a document or policy (Turoff & Linstone, 1975). The accuracy of the results is only as good as the opinions that go into the responses. The Delphi has been used to identify problems, define needs, establish priorities, plan curriculum, and identify and evaluate solutions (Billingsley, 1984; Borg & Gall, 1984; Linstone & Turoff, 1975; Volk, 1993).

The Delphi technique has three characteristics that distinguish it from conventional face-to-face group interaction: (a) anonymity, (b) iteration with controlled feedback, and (c) statistical group response (Martino, 1983). The Delphi can have from two to five rounds (phases).

The stages of this Delphi study are:

1. Preparation of a draft questionnaire.
2. Selection of experts.
3. Pilot of the questionnaire framework.
4. Validation of the questionnaire framework.(Phase 1)  
The five design guiding principles for constructivist based learning environments are reviewed for adequacy and completeness.
5. Circulation of the questionnaire. (Phase 2)  
Two requests for information are added beneath each guiding principle:
  - ¥ Provide one example-appropriate for School District # 627-of an learning environment design component or experience that would exemplify this principle.
  - ¥ Identify the essential elements of teacher preparation needed by the District # 627 teachers to implement the design or experience.
 Responses are returned to the project director.
6. Analysis of Phase 2 results, return to the experts. (Phase 3)  
Similar responses are combined; items of lesser importance may be dropped to keep the list at a reasonable length; each item is stated as clearly as possible. Responses are placed into a 6 point Likert scale format, ranging from strongly disagree to strongly agree in rating.
7. Analysis of Phase 3 results, return to the experts. (Phase 4)  
During Phases Four and Five, the questionnaires not only ask questions, but provide information to the group members about the degree of group consensus. The project manager prepares a statistical summary of the forecasts, as well as a consolidated summary of the panel's reasons for accepting or rejecting a response. The questionnaires for Phases Four and Five consist of lists of responses to each question, the medians and quartiles for the previous phase, and a request to reconsider or explain any answers which fall outside of the consensus zone (interquartile range).
8. Analysis of Phase 4 results, return to the experts. (Phase 5)
9. Analysis of Phase 5 results, preparation of the final report. (Twiss, 1992)

Delphi sequences are considered successful when they reach stability, that is, no further change of opinion is offered, with the reasons for divergence from the group clearly displayed. Generally, after panel members offer their rationale for answers, the subsequent responses tend to cluster. This convergence results from the transfer

of information and interaction among the panel members and leads to consensus (Martino, 1983).

The Delphi technique is a feasible and effective method of obtaining the benefits of group participation for information gathering or forecasting preparation while at the same time diminishing the effects of face-to-face committee action. Providing that the Delphi is well constructed and carried out, it can be an extremely useful tool for gathering knowledgeable experts to consensus on a specific topic.

### Definitions

**Delphi Technique:** A method for achieving a structured anonymous interaction between carefully selected authorities through the use of a questionnaire and controlled feedback. The questionnaires not only ask questions, but provide information to the panel members about the degree of group consensus and the arguments presented by the group members against or for various positions (Martino, 1983). The results should represent the best opinion available; so, the panel should be composed of the most knowledgeable authorities available.

**Dynamic:** Characterized by continuous change, activity, or progress.

**Learning Environments:** Comprehensive, integrated systems designed to support the individual's efforts to understand that which he or she determines to be important. They are not unitary in meaning, but are found in varied forms. Still, common assumptions are shared which are represented by a set of dimensions: scope, content integration, user-activity, and pedagogical orientation (Hannafin, 1992; Hannafin, Hall, Land, Hill, 1994)

**MOO:** A MOO ("Multi-User Domains, Object Oriented" Environments) is an electronic text based virtual environment that simulates the physical world. Within a MOO, you can connect to a host and arrive in a virtual room. You can converse with anyone else who is connected to the same host and who is in your "room." You can move from room to room, and you can page people in other rooms. The rooms "exist" because they have been described, and that description becomes crucial to the activities that go on within it. For further information, visit the WWW site: <http://www.du.org./places/du/cybercomp.html>

**Reflexivity:** The ability to consciously be aware of one's own learning, belief system, actions, and knowledge; reflection of our reflections, thinking about our thinking process, knowing how we know (Knuth & Cunningham, 1991).

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APPENDIX B2

PHASE 2 MATERIALS

Please read the [Introduction](#) to review the context for this project. For the reasoning behind the changes to the design guiding principles read: [Reasons](#)

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## School District #627 Instructional Support Project

### Phase 2: Questionnaire Development

For a working definition of constructivism visit: [Constructivism](#). Given our definition of constructivism, the following five design guiding principles for constructivist-based instructional design have been created by the project coordinator following an extensive review of literature, consultation with several knowledgeable individuals in the field, and the [responses of project panel members](#).

Phase 2 of this project asks the project panel members to address the issue of knowledge necessary for K-12 teachers to implement the principles. Panel members are asked to answer, for each principle, the following two questions:

1. Provide one example-appropriate for [School District # 627](#) -of a learning environment design component or experience that would exemplify this principle.
2. Identify the essential elements of teacher preparation needed by the District #627 teachers to implement the design or experience.

For examples of sample responses to questions one and two, see: [sample responses](#). Several panel members have found a single "question one" example appropriate for several principles. If you choose to do likewise, please indicate your intention in the "question one" response box(es) under the succeeding principle(s).

The intent of this phase of the process is to identify the components necessary for the teachers to develop constructivist based distance education learning environments. Each component will then be put into questionnaire form which, in successive phases, panel members will use to evaluate each component's importance and appropriateness to the Instructional Support Project for District # 627 teachers.

To begin the response process, enter your alias in the "Alias" box (do not hit return to move on, use scroll instead). Classnet is upper and lower case specific, use the identical replication of your chosen alias. Then, from a constructivist viewpoint, answer the two questions provided for each of the five design principles presented. You must type a response or insert a return in each box before submitting your Phase 2 responses. If you wish to clear your answers and start over, click the "clear and redo" button at the end of the document. If you wish to review or revise your comments, use the scrolling arrow to take you back to a specific principle. Click the submit button to send your comments to the project coordinator.

### Design Guiding Principles for Constructivist Based Distance Learning

"it [P#1] has the feel of starting in the middle of the instructional design process."

The principles were reordered so they fit with the flow of a design process. The following is an explanation for the reordering:

- Moved P4 to P1 because it is based in metacognition; used the term from Cunningham, Duffy, and Knuth reflexivity: "a reflection of our reflections, thinking about our thinking process, knowing how we know" instead of multiple perspectives because it was provided an expanded definition of intent of the learning process. Several respondents identified this principle as "critical aspect" (#1 and #2), "essential component" (#9); and "heart of it" (#10) which also made the move to #1 appropriate.
- #2 takes into account the learner in the design of the learning environment. Since constructivist's identify that knowledge construction is a "function of one's prior experiences, mental structures, and beliefs that are used to interpret object and events" (Marra & Jonassen), the learner must be an early and integral piece in the design and implementation of learning environments.
- #3 addresses the need to create learning environments in a context that the student will see as potentially creating usable (i.e. transferable) knowledge. Because the learners come to the environment at varying levels from novice to expert, the opportunity for teacher mediation was provided. This would be a logical step as the students move into the learning environment.
- #4 speaks to the importance of interactions within the environment these would naturally occur after the relevancy of the learning was identified by the students.
- #5 deals with assessment. Constructivist believe that assessment of learning should evolve out of the learning process through the negotiation between student and teacher thus, it would be logical to have it follow principles dealing with the learning environment creation and students learning activities.

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The following definition of constructivism will be included in the next phase to provide a more focused base for the discussion, it is quoted from Fosnot (1996):

Constructivism is a theory about knowledge and learning; it describes both what "knowing" is and how one "comes to know." . . . the theory describes knowledge as temporary, developmental, nonobjective, internally constructed, and socially and culturally mediated. Learning from this perspective is viewed as a self-regulatory process of struggling with the conflict between existing personal models of the world and discrepant new insight, constructing new representations and models of reality as a human meaning-making venture with culturally developed tools and symbols, and further negotiating such meaning through cooperative social activity, discourse, and debate.

Although constructivism is not a theory of teaching, it suggests taking a radically different approach to instruction . . . a constructivist view of learning suggests an approach to teaching that gives learners the opportunity for concrete, contextually meaningful experience through which they can search for patterns, raise their own questions, and construct their own models, concepts, and strategies. The classroom in this model is seen as a minisociety, a community of learners engaged in activity, discourse, and reflection. The traditional hierarchy of teacher as the autocratic knower and learner as the unknowing, controlled subject studying to learn what the teacher knows begins to dissipate as teachers assume more of a facilitator's role and learners take on more ownership of the ideas. Indeed, autonomy, mutual reciprocity of social relations, and empowerment become the goals. (p. ix)

Fosnot, C.T. (1996). *Constructivism: Theory, perspectives, and practice*.  
New York, NY: Teachers College Press

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Phase 2

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## Constructivism

The following definition of constructivism is provided as the foundation for the *Guiding Design Principles for Creating Constructivist Based Distance Learning Environments*. It is quoted from Fosnot (1996):

"Constructivism is a theory about knowledge and learning; it describes both what 'knowing' is and how one 'comes to know.' . . . the theory describes knowledge as temporary, developmental, nonobjective, internally constructed, and socially and culturally mediated. Learning from this perspective is viewed as a self-regulatory process of struggling with the conflict between existing personal models of the world and discrepant new insight, constructing new representations and models of reality as a human meaning-making venture with culturally developed tools and symbols, and further negotiating such meaning through cooperative social activity, discourse, and debate.

Although constructivism is not a theory of teaching, it suggests taking a radically different approach to instruction . . . a constructivist view of learning suggests an approach to teaching that gives learners the opportunity for concrete, contextually meaningful experience through which they can search for patterns, raise their own questions, and construct their own models, concepts, and strategies. The classroom in this model is seen as a minisociety, a community of learners engaged in activity, discourse, and reflection. The traditional hierarchy of teacher as the autocratic knower and learner as the unknowing, controlled subject studying to learn what the teacher knows begins to dissipate as teachers assume more of a facilitator's role and learners take on more ownership of the ideas. Indeed, autonomy, mutual reciprocity of social relations, and empowerment become the goals." (p. ix)

Fosnot, C.T. (1996). *Constructivism: Theory, perspectives, and practice*. New York, NY: Teachers College Press

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APPENDIX B3

PHASE 3 MATERIALS

## School District #627 Instructional Support Project

### Phase 3 Introduction

If you have not done so, please review the context for this project, located at the [Instructional Support Project Scenario](#), before proceeding.

Directions for responding:

**Categories:** Categories have been created using the appropriate principle as a base. Below each category are located Learning Environment Design Components or Experiences and their Elements, as suggested by the panel members.

**Learning Environment Design Components or Experiences:** Each category contains at least one subcategory that represents a learning environment design component or experience that panel members have stated exemplifies the category. You will assess each category's importance in exemplifying Principle 1, then click the appropriate button for your response.

**Elements:** Below each design component or experience are located elements that panel members stated were important for teacher preparation to implement the learning environment design component or experience. You will assess the importance of each element in regards to the needed preparation of K-12 teachers to implement the design or experience.

**Overview:** For a shortened overview of each category, learning environment design component or experience and its supporting elements, click [overview](#).

**Responding:** After reading each statement, please click in the radio button you feel best represents your opinion of the statement. Each statement will have the following response format:

<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/>
Unimportant	Of Little Importance	Moderately Important	Important	Very Important	<- Check One
Comments:					
<div style="border: 1px solid black; height: 150px; width: 100%; position: relative;"> <div style="position: absolute; top: 5px; right: 5px;">↑</div> <div style="position: absolute; bottom: 5px; right: 5px;">↓</div> <div style="position: absolute; bottom: 5px; left: 5px;">←</div> <div style="position: absolute; bottom: 5px; right: 5px;">→</div> </div>					

**Comments:** A comment box is also provided below each statement for your convenience. If you chose not to respond in the comment box, please remember to place a return in the box.

**Submission:** Each principle will be submitted separately. A submission button and hyperlinks to move to

the next principle are provided at the end of each principle.

---

[Principle 1](#)

[Principle 2](#)

[Principle 3](#)

[Principle 4](#)

[Principle 5](#)

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## School District #627 Instructional Support Project Phase 3 -- Principle 1

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Directions for responding to Principle 1:

Categories: Principle One has been subdivided into three categories:

Category 1: Provide learning experiences that promote student reflexivity about the content learned in order to develop the student's self-awareness of the constructedness of knowledge.

Category 2: Provide learning experiences that promote student reflexivity about the learning process in order to develop the student's self-awareness of the constructedness of knowledge.

Category 3: Provide learning experiences which promote student reflexivity about the learning process in order to develop student's self-control over the learning process

Learning Environment Design Component or Experience: Each category contains at least one subcategory that represents a learning environment design component or experience that panel members have stated exemplifies the category. You will assess each category's importance in exemplifying Principle 1, then click the appropriate button for your response.

Elements: Below each design component or experience are located elements that panel members stated were important for teacher preparation to implement the learning environment design component or experience. You will assess the importance of each element in regards to the needed preparation of K-12 teachers to implement the design or experience.

Overview: An overview of each category, learning environment design component or experience, and supporting elements.

Responding: After reading each statement, please click in the radio button you feel best represents your opinion of the statement. Each statement will have the following response format:

Unimportant; Of Little Importance; Moderately Important; Important;  
Very Important.

Comments: A comment box is also provided below each statement for your convenience. If you chose not to respond in the comment box, please remember to place a return in the box.

Submission: EACH OF THE FIVE PRINCIPLES WILL BE SUBMITTED SEPARATELY. A submission button and hypertext to move to the next principle are provided at the end of each principle.

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First, enter your alias:

### Principle 1

Given an understanding of and positive attitude towards constructivism: Provide learning experiences that promote student reflexivity about both the content learned and the learning process in order to develop the student's self-awareness of the constructedness of knowledge and the student's self-control over the learning process.

Category 1: Provide learning experiences that promote student reflexivity about the content learned in order to develop the student's self-awareness of the constructedness of knowledge

A1. How important is the sharing of information and discussion about learning between students to the provision of learning experiences that promote student reflexivity about the content learned in order to develop the student's self-awareness of the constructedness of knowledge?

Unimportant	Of Little Importance	Moderately Important	Important	Very Important	<- Check One

Comments:

← → ↶ ↷

A1.1. To implement sharing of information and discussion about learning between students, how important is it that a District #627 teacher receives preparation in creating supportive, positive environments for sharing and discussion?

Unimportant	Of Little Importance	Moderately Important	Important	Very Important	<- Check One

Comments:

← → ↶ ↷

## APPENDIX C

### DELPHI PRINCIPLES, CATEGORIES, AND ITEM STATEMENTS WITH FINAL RESULTS

**PRINCIPLE ONE:** Given an understanding of and positive attitude towards constructivism: Provide learning experiences that promote student reflexivity about both the content learned and the learning process in order to develop the student's self-awareness of the constructedness of knowledge.

**Category 1:** Provide learning experiences that promote student reflexivity about the content learned in order to develop student's self-awareness of the constructedness of knowledge

1. **A1. H/.44/VI = 4.78**  
How important is the sharing of information and discussion about learning between students to the provision of learning experiences that promote student reflexivity about the content learned in order to develop the student's self-awareness of the constructedness of knowledge?
2. **A1.1. M/.59/ VI = 4.69**  
To implement sharing of information and discussion about learning between students, how important is it that a District #627 teacher receives preparation in creating supportive, positive environments for sharing and discussion?
3. **A1.2. M/.77/ VI = 4.12**  
To implement sharing of information and discussion about learning between students, how important is it that a District #627 teacher receives preparation in the tools used for the creation of small or large group technological discussion environments (e.g., computer conferencing, video conferencing, virtual conferencing)?
4. **A1.3. M/.73/ MI = 3.31**  
To implement sharing of information and discussion about learning between students, how important is it that a District #627 teacher receives preparation in the tools used for electronic transmittal of information about knowledge construction (e.g., email, listserv, WWW, or FTP)?
5. **A2. L/.95/ I = 4.25**  
How important is expert modeling of knowledge development and structures to the provision of learning experiences that promote student reflexivity about the content learned in order to develop the student's self-awareness of the constructedness of knowledge?
6. **A2.1. M/.67/MI = 3.5**  
To implement modeling of knowledge development and structures, how important is it that a District #627 teacher receives preparation in creating experiences where discipline experts model multiple knowledge structures and expertise (e.g., listserv discussions, computer conferences, or video conferencing)?
7. **A2.2. M/.65/MI = 3.4**  
To implement modeling of knowledge development and structures, how important is it that a District #627 teacher receives preparation in skills necessary to create remote apprenticeship/mentoring environments?
8. **A2.3. M/.61/ MI = 3.25**  
To implement modeling of knowledge development and structures, how important is it that a District #627 teacher receives preparation in strategies for analyzing expert interactions to discuss the knowledge and skills experts use?
9. **A3. H/.41/ VI = 4.78**  
How important is involving students in knowledge construction activities to the provision of learning experiences that promote student reflexivity about the content learned in order to develop the student's self-awareness of the constructedness of knowledge?



10. A3.1.  $M/.52/ VI = 4.69$   
To implement the involvement of students in knowledge construction activities, how important is it that a District #627 teacher receives preparation in creating problem solving learning environments that require students to set goals and knowledge development strategies?
11. A3.2.  $M/.57/ I = 4.25$   
To implement the involvement of students in knowledge construction activities, how important is it that a District #627 teacher receives preparation in methods of documenting student's growing understanding (e.g., concept maps, journals, web sites)?
12. A3.3.  $H/.45/ MI = 3.19$   
To implement the involvement of students in knowledge construction activities, how important is it that a District #627 teacher receives preparation in the use of electronic student journals to record strategies used to achieve learning goals?
13. A3.4.  $L/.97/ I = 3.6$   
To implement the involvement of students in knowledge construction activities, how important is it that a District #627 teacher receives preparation in use of activities such as compare/contrast, list generation, developing procedures (c.f., Sherry and Trigg, most recent EdTech issue)?
14. A3.5.  $M/.6/ I = 4.4$   
To implement the involvement of students in knowledge construction activities, how important is it that a District #627 teacher receives preparation in strategies for probing students to think about their own thinking to help understand what they learned from an experience?
15. A3.6.  $L/.92/ I = 4.5$   
To implement the involvement of students in knowledge construction activities, how important is it that a District #627 teacher receives preparation in creating learning environments that allow student's to construct personal learning environments focused on the concepts and principles learned?

Category 2: Provide learning experiences that promote student reflexivity about the learning process in order to develop the student's self-awareness of the constructedness of knowledge.

16. **A4.  $M/.61/ VI = 4.57$**   
How important is student modeling of and reflexivity on the learning process to the provision of learning experiences that promote student self-awareness of the constructedness of knowledge?
17. A4.1.  $M/.57/ I = 4.25$   
To implement the student modeling of and reflexivity on learning processes, how important is it that a District #627 teacher receives preparation in strategies and tools for students' construction of their own learning environments and explanations of why they did it that way?
18. A4.2.  $H/.5/ MI = 3.14$   
To implement the student modeling of and reflexivity on learning processes, how important is it that a District #627 teacher receives preparation in the use of tools to construct student journals for documentation of and reflection on the learning process?
19. A4.3.  $M/.57/ I = 4.25$   
To implement the student modeling of and reflexivity on learning processes, how important is it that a District #627 teacher receives preparation in the use of tools that permit students to reflect on their constructions, compare their views to those of others, and modify their understandings accordingly?

20. **A5. M/.69/MI = 3.25**

How important are "expert" modeling examples of the learning process to the provision of learning experiences that promote student reflexivity about the learning process that promote student self-awareness of the constructedness of knowledge?

21. **A5.1. M/.6/ I = 4.4**

To implement use of "expert" modeling examples of learning processes, how important is it that a District #627 teacher receives preparation in modeling their own processes of reflexivity?

22. **A5.2. H/.45/ MI = 3.19**

To implement use of "expert" modeling examples of learning processes, how important is it that a District #627 teacher receives preparation in tools that support the viewing of and interaction with experts engaged in formulating the problem, developing alternative solutions, and deciding which solution to use?

23. **A5.3. M/.6/ MI = 3.08**

To implement use of "expert" modeling of learning processes, how important is it that a District #627 teacher receives preparation in analyzing expert interactions to discuss expert approaches to problem solving, reflection, and metacognition?

Category 3: Provide learning experiences which promote student reflexivity about the learning process in order to develop student's self-control over the learning process.

24. **A6. M/.52/ VI = 4.69**

How important is allowing student self-control over the learning process to the provision of learning experiences that promote student reflexivity about the learning process in order to develop student's self-control over the learning process?

25. **A6.1. M/.73/ VI = 4.69**

To implement student's self-control over the learning process, how important is it that a District #627 teacher receives preparation in creating learning environments that allow students to choose the angle from which they approach a topic they wish to study?

26. **A6.2. M/.73/ VI = 4.57**

To implement student's self-control over the learning process, how important is it that a District #627 teacher receives preparation in strategies for task definition (e.g., rephrasing the problem into questions, recognition of multiple approaches)?

27. **A6.3. M/.73/ VI = 4.69**

To implement student's self-control over the learning process, how important is it that a District #627 teacher receives preparation in multiple approaches to knowledge construction and interpretation?

28. **A6.4. L/1.05/ I = 3.67**

To implement student's self-control over the learning process, how important is it that a District #627 teacher receives preparation in strategies used to survey a student's efforts and quickly identify deficiencies in the learning strategies?

29. **A6.5. M/.6/ I = 4.4**

To implement student's self-control over the learning process, how important is it that a District #627 teacher receives preparation in creating learning environments that offer real world learning experiences that students are asked to interpret?

30. **A6.6. H/.32/ MI = 3.15**

To implement student's self-control over the learning process, how important is it that a District #627 teacher receives preparation in tools to support students' documentation of their learning?

31. **A6.7. M/.54/ MI = 3.42**

To implement student's self-control over the learning process, how important is it that a District #627 teacher receives preparation in the use of technological tools that allow students to arrange and rearrange their knowledge construction in multiple ways?

**Principle 2: Create dynamic, challenging learning environments that are appropriate for the student's level of expertise, development, and culture and that encourage, facilitate, and support student's taking ownership of the learning process.**

**Category 1: Creation of dynamic, challenging learning environments that are appropriate for the student's level of expertise, development, and culture.**

**1. B1. M/.65/ I = 4.2**

How important are strategies to analyze the student's level of expertise, development, and culture to the creation of learning environments that are appropriate for the student's level of expertise, development, and culture?

**2. B1.1. M/.67/ I = 3.92**

To implement strategies to analyze the student's level, how important is it that a District #627 teacher receives preparation in methods of teacher directed- and student self-assessment for identification of entry level skills and knowledge?

**3. B1.2. H/.5/ MI = 3.5**

To implement strategies to analyze the student's level, how important is it that a District #627 teacher receives preparation on creating opportunities for teachers reflection and documentation of student needs (e.g., participation on teaching teams)?

**4. B1.3. L/.86/ I = 4.57**

To implement strategies to analyze the student's level, how important is it that a District #627 teacher receives preparation in methods of soliciting student ideas, goals, strategies or performance criteria?

**5. B2. H/.5/ I = 4.5**

How important is the use of problem or case based learning to the creation of dynamic, challenging learning environments that are appropriate for the student's level of expertise, development, and culture?

**6. B2.1. M/.7/ I = 4.38**

To implement the use of appropriate problem or case based learning, how important is it that a District #627 teacher receives preparation in shaping the size of real world problems to adapt the issues involved to a level appropriate for student's capabilities?

**7. B2.2. H/.3/ I = 4**

To implement the use of appropriate problem or case based learning, how important is it that a District #627 teacher receives analytical skill development (i.e., learning to break a complex situation into component parts, identify essential and non-essential elements of the problem solving situation)?

**8. B2.3. M/.52/ VI = 4.69**

To implement the use of appropriate problem or case based learning, how important is it that a District #627 teacher receives modeling and coaching support as they design and implement problems for the classroom?

**Category 2: Create dynamic, challenging learning environments that encourage, facilitate, and support students taking ownership of the learning process.**

**9. B3. H/.47/ I = 4.31**

How important is students' establishment of plans to pursue their corresponding problem to the creation of dynamic, challenging learning environments that encourage, facilitate, and support student's taking ownership of the learning process?

**10. B3.1. H/.27/ VI = 4.96**

To implement the use of students' establishment of plans to pursue their corresponding problem, how important is it that a District #627 teacher receives preparation in serving as a guide/facilitator for students rather than as an expert?

11. B3.2. M/.82/ I = 4.33  
To implement the use of students' establishment of plans to pursue their corresponding problem, how important is it that a District #627 teacher receives preparation in the many ways understanding can be acquired?
12. B3.3. M/.8/ I = 4.33  
To implement the use of students' establishment of plans to pursue their corresponding problem, how important is it that a District #627 teacher receives preparation in guiding students to recognize their ability to carry out their research strategies?
13. B3.4. M/.82/ I = 3.67  
To implement the use of problem or case based learning, how important is it that a District #627 teacher receives preparation in use of tools (e.g., e-mail and WWW) that allow the monitoring and facilitating of student progress?

Principle 3: Given a relatively defined domain of knowledge and learning goals, design authentic instruction situations that have relevance or, through teacher mediation, can become relevant to students and that actively engage students in the construction of transferable meaning.

Category 1: Given a relatively defined domain of knowledge and learning goals, design authentic instruction situations.

1. **C1. M/.51/ VI = 4.78**  
How important is the grounding of issues in the real world to the design of authentic instruction situations?
2. C1.1. M/.54/ I = 4.57  
To implement the grounding of issues in the real world, how important is it that a District #627 teacher receives preparation in the use of content domains in the broad societal context of super-systems (e.g., social systems, social issues) as the stimulus for learning not just knowledge of narrow content domains?
3. C1.2. M/.61/ OLI = 2.43  
To implement the grounding of issues in the real world, how important is it that a District #627 teacher receives preparation in the use of a skill by activity grid that identifies where formal concepts and everyday contexts intersect (used during planning to heighten awareness of teachers as to the nature of the connections with formal curriculum and to illustrate to parents, teachers, etc. how the activity reinforces, extends, etc., the school's curriculum [i.e., ward off the critics])?
4. C1.3. L/1.06/ MI = 3.38  
To implement the grounding of issues in the real world, how important is it that a District #627 teacher receives preparation in creating simple cases that closely represent a real-world task (e.g., Reigeluth's simplifying conditions method)?
5. C1.4. M/.65/ I = 3.8  
To implement the grounding of issues in the real world, how important is it that a District #627 teacher receives preparation in skills and techniques necessary to develop a situation that requires students to create and manage a project that deals with the topic/subject at hand (e.g., civics class: run an election campaign -- or have them run for office)?
6. **C2. H/.41/ VI = 4.78**  
How important is student motivation to the design authentic instruction situations?
7. C2.1. H/.5/ I = 4.14  
To implement the use of student motivation in the design of authentic instructional situation, how important is it that a District #627 teacher receives preparation in understanding, from an instructional design perspective, the inculcating of fantasy, curiosity, challenge, beauty, and social recognition into learning experiences (c.f., the research by Malone and Lepper on motivation in technology-based learning environments)?

Category 2: Given a relatively defined domain of knowledge and learning goals, design authentic instruction situations that have relevance or, through teacher mediation, can become relevant to students.

8. **C3. M/.75/ I = 4.5**

How important is teacher mediation between the knowledge domain and the students to the design of authentic instruction situations that have relevance or, through teacher mediation, can become relevant to students?

9. **C3.1. M/.57/ I = 4.25**

To implement the use of student motivation in the design of authentic instructional situation, how important is it that a District #627 teacher receives preparation in helping students make connections between what they are doing and what they already know?

10. **C3.2. M/.57/ I = 4.25**

To implement the use of teacher mediation between the knowledge domain and the students, how important is it that a District #627 teacher receives preparation in tools and strategies for finding and using relevant resources in a virtual environment?

11. **C3.3. H/.52/ VI = 4.69**

To implement the use of teacher mediation between the knowledge domain and the students, how important is it that a District #627 teacher receives preparation in evaluating the quality and authenticity of resources ?

Category 3: Given a relatively defined domain of knowledge and learning goals, design authentic instruction situations that actively engage students in the construction of transferable meaning.

12. **C4. M/.77/ MI = 3.42**

How important is insuring that the learner practices what is essential for the transfer situation to the design of authentic instruction situations that actively engage students in the construction of transferable meaning?

13. **C4.1. M/.65/ I = 3.6**

To implement insuring that the learner practices what is essential for the transfer situation, how important is it that a District #627 teacher receives preparation in techniques for working in interdisciplinary teams?

14. **C4.2. H/.5/ I = 4.14**

To implement insuring that the learner practices what is essential for the transfer situation, how important is it that a District #627 teacher receives preparation in techniques for relating material across disciplines?

15. **C4.3. M/.56/ MI = 3.29**

To implement insuring that the learner practices what is essential for the transfer situation, how important is it that a District #627 teacher receives preparation in the use of tools in the virtual environment necessary to monitor and nourish the interaction among students ?

Principle 4: Develop learning experiences that encourage the social negotiation of knowledge to provide learners with the opportunity to evaluate individual understandings of concepts and to expand individual and shared understandings.

Category 1: Develop learning experiences that encourage the social negotiation of knowledge to provide learners with the opportunity to evaluate individual understandings of concepts.

1. **D1. H/.44/ VI = 4.78**

How important is the embedding of problem solving in a social framework in which learners are inevitably exposed to multiple perspectives and a spectrum of individual problem solving strategies to the development of learning experiences that encourage the social negotiation of knowledge to provide learners with the opportunity to evaluate individual understandings of concepts?

2. D1.1. M/.59/ I = 3.69  
To implement the embedding of problem solving in a social framework, how important is it that a District #627 teacher receives preparation in the understanding and application of Vygotskian principles?
3. D1.2. M/.51/ VI = 4.78  
To implement the embedding of problem solving in a social framework, how important is it that a District #627 teacher receives preparation in the skills of negotiation, conflict resolution, and mediation?
4. D1.3. M/.54/ I = 4.42  
To implement the embedding of problem solving in a social framework, how important is it that a District #627 teacher receives preparation in the understanding and use of ideas from situated cognition?
5. D1.4. M/.54/ I = 4.57  
To implement the embedding of problem solving in a social framework, how important is it that a District #627 teacher receives preparation in creating learning environments that allow students to compare individual problem solution strategies?
6. D1.5. M/.54/ I = 4.57  
To implement the embedding of problem solving in a social framework, how important is it that a District #627 teacher receives preparation in strategies to assist students in expressing and defending ideas without becoming threatened?
7. D1.6. M/.51/ I = 3.71  
To implement the embedding of problem solving in a social framework, how important is it that a District #627 teacher receives preparation in the use of tools (e.g., Lotus Notes) that support student posting and feedback ?
8. D1.7. M/.8/ I = 4.12  
To implement the embedding of problem solving in a social framework, how important is it that a District #627 teacher receives preparation in the development of tasks that require students at different sites to provide feedback and assistance to one another?

Category 2: Develop learning experiences that encourage the social negotiation of knowledge to expand individual and shared understandings.

9. **D2. H/.41/ VI = 4.78**  
How important is the use of collaboration and interaction in a disciplined way that leads to sustained inquiry to the development of learning experiences that encourage the social negotiation of knowledge to expand individual and shared understandings?
10. D2.1. M/.81/ OLI = 2.62  
To implement the use of collaboration and interaction, how important is it that a District #627 teacher select and buy into a model(s) of collaboration, use it until it becomes automatic, and then teach it to the students to provide clear directions about how to do these things?
11. D2.2. H/.45/ I = 3.81  
To implement the use of collaboration and interaction, how important is it that a District #627 teacher receives preparation in modeling for students how one arrives at collective criteria for judging the worth of various ideas and approaches?
12. D2.3. M/.54/ I = 4.42  
To implement the use of collaboration and interaction, how important is it that a District #627 teacher to receives preparation in the use of collaborative projects to develop habits of good teamwork and clear communication?
13. D2.4. M/.57/ I = 3.75  
To implement the use of collaboration and interaction, how important is it that a District #627 teacher receives preparation in the development of questioning strategies to elicit student's rationale and evidence?

## 14. D2.5. M/.61/ I = 3.75

To implement the use of collaboration and interaction, how important is it that a District #627 teacher receives preparation in strategies for processing ongoing discourse to raise other ways ideas might be conceptualized?

## 15. D2.6. M/.73/ MI = 3.31

To implement the use of collaboration and interaction, how important is it that a District #627 teacher receives preparation in the tools that may be used to facilitate group problem solving (e.g., collaborative software like Apple's "Co-Learning" System, concept mapping software like Inspiration, virtual environment software like Netscape)?

Principle 5: Use dynamic, authentic assessment that is embedded in the instructional process to assess both student learning and the learning environment.

Category 1: Use dynamic, authentic assessment that is embedded in the instructional process to assess student learning.

## 1. E1. M/.52/ VI = 4.69

How important is student and instructor negotiation of performance criteria or rubrics based on the learning goals and objectives to the use of dynamic, authentic assessment that is embedded in the instructional process to assess student learning?

## 2. E1.1. H/.47/ VI = 4.69

To implement student and instructor negotiation of performance criteria or rubrics, how important is it that a District #627 teacher receives preparation in identifying acceptable performance criteria or rubrics and remaining open to accepting student criteria they had not thought of originally?

## 3. E1.2. M/.54/ I = 4.57

To implement student and instructor negotiation of performance criteria or rubrics, how important is it that a District #627 teacher receives preparation in various methods and means for demonstrating the acquisition of relevant skills and knowledge?

## 4. E1.3. M/.73/ I = 4.57

To implement student and instructor negotiation of performance criteria or rubrics, how important is it that a District #627 teacher receives preparation in maintaining an overall assessment system that includes a balanced set of components (i.e., small-group and individualized; authentic and externally imposed; benchmark and routing; formal and informal; product and process; portfolios and skills demonstrations; embedded in instruction and tacked on)?

## 5. E1.4. M/.73/ I = 4.57

To implement student and instructor negotiation of performance criteria or rubrics, how important is it that a District #627 teacher receives preparation in understanding the concept of systemic validity (cf. Frederiksen & Collins, 1989) which recognizes that the evaluation process signals to teachers and students what kinds of teaching and learning activities they are expected to carry out?

## 6. E2. M/.65/ I = 4.2

How important are portfolios to the use of dynamic, authentic assessment that is embedded in the instructional process to assess student learning?

## 7. E2.1. H/.47/ I = 4.31

To implement the use of portfolios to document learning, how important is it that a District #627 teacher receives preparation in the use of portfolios to assess learning (e.g., significance of goals, effort, productive plans, depth of reflection)?

## 8. E2.2. M/.51/ I = 3.71

To implement the use of portfolios to document learning, how important is it that a District #627 teacher receives preparation in the use of tools for portfolio maintenance that document the learning?

9. **E3. H/.41/ I = 4.22**

How important are the critiques of personal, classmember, or group work to the use of dynamic, authentic assessment that is embedded in the instructional process to assess student learning?

10. **E3.1. M/.54/ I = 4.57**

To implement the use of critiques or assessment of personal, classmember, or group work, how important is it that a District #627 teacher receives preparation in methods of providing honest, informed, and constructive criticism of thinking and argumentation?

11. **E3.2. M/.57/ OLI = 2.92**

To implement the use of critiques of personal, classmember, or group work, how important is it that a District #627 teacher receives preparation in the use of experts to provide feedback as to the clarity of the position presented and recommend other resources to assist in further understanding of the problem/issue being studied?

12. **E3.3. H/.33/ VI = 4.85**

To implement the use of critiques of personal, classmember, or group work, how important is it that a District #627 teacher receives preparation in constructing and implementing performance assessments?

13. **E4. M/.54/ I = 4.57**

How important is teachers obtaining an accurate reading on how students are approaching a problem to the use of dynamic, authentic assessment that is embedded in the instructional process to assess student learning?

14. **E4.1. M/.51/ I = 3.71**

To implement teachers obtaining an accurate reading on how students are approaching a problem, how important is it that a District #627 teacher receives preparation in inferring understanding from students' \*talk\* about what they know and did?

15. **E4.2. H/.48/ MI = 3.19**

To implement teachers obtaining an accurate reading on how students are approaching a problem, how important is it that a District #627 teacher receives preparation in methods that require student's summarization of perceptions on the effectiveness of the decisions made through the review of outcomes derived from the decisions?

16. **E5. M/.61/ MI = 3.43**

How important are the use of tools to the use of dynamic, authentic assessment that is embedded in the instructional process to assess student learning?

17. **E5.1. M/.54/ I = 3.58**

To implement the use of tools, how important is it that a District #627 teacher receives training in tools that can help manage the complexity of data handling and management found in authentic assessment?

18. **E5.2. H/.41/ MI = 3.22**

To implement the use of tools, how important is it that a District #627 teacher receives training in programs that provide the teacher with an accurate reading on how students are approaching a problem in order to discuss strategies?

Category 2: Use dynamic, authentic assessment that is embedded in the instructional process to assess the learning environment.

19. **E6. M/.62/ I = 4.5**

How important is understanding a wide range of skill areas, plans, and products to the use dynamic, authentic assessment that is embedded in the instructional process to assess the learning environment?

20. **E6.1. M/.87/ MI = 3.67**

How important is it that a District #627 teacher receives preparation in developing a "performance technologists' view," i.e., a broad view of all factors affecting learning including physical environment, communication, group structure and process, motivation, prior knowledge and experience, etc.?



21. E6.2. M/.51/ I = 4.29

How important is it that a District #627 teacher receives preparation in observing and understanding what students do and say while working in the environment?

## APPENDIX D

### TRAINING ELEMENTS ASSOCIATED WITH TRAINING THREADS

<u>Thread</u>	<u>Training Element</u>
<u>Learning guide or facilitator roles for teachers</u>	
	<ol style="list-style-type: none"> <li>1. Creating supportive, positive environments for sharing and discussion</li> <li>2. Creating learning environments that allow students to choose the angle from which they approach a topic they wish to study</li> <li>3. Strategies for task definition (e.g., rephrasing the problem into questions, recognition of multiple approaches)</li> <li>4. Evaluating the quality and authenticity of resources</li> <li>5. Skills of negotiation, conflict resolution, and mediation</li> <li>6. Strategies to assist students in expressing and defending ideas without becoming threatened</li> <li>7. Strategies for probing students to think about their own thinking to help understand what they learned from an experience</li> <li>8. Modeling their own processes of reflexivity</li> <li>9. Use of tools (e.g., e-mail and WWW) that allow the monitoring and facilitating of student progress</li> <li>10. Helping students make connections between what they are doing and what they already know</li> <li>11. Development of tasks that require students at different sites to provide feedback and assistance to one another</li> </ol>
<u>Training needs of students to carry out learning strategies</u>	
	<ol style="list-style-type: none"> <li>12. Methods of documenting student's growing understanding (e.g., concept maps, journals, web sites)</li> <li>13. Strategies and tools for students' construction of their own learning environments and explanations of why they did it that way</li> <li>14. Use of tools that permit students to reflect on their constructions, compare their views to those of others, and modify their understandings accordingly</li> <li>15. Guiding students to recognize their ability to carry out their research strategies</li> <li>16. Tools and strategies for finding and using relevant resources in a virtual environment</li> <li>17. Techniques for working in interdisciplinary teams</li> <li>18. Techniques for relating material across disciplines</li> <li>19. Use of collaborative projects to develop habits of good teamwork and clear communication</li> <li>20. Use of tools (e.g., Lotus Notes) that support student posting and feedback</li> </ol>
<u>Embedding of assessment within the learning process</u>	
	<ol style="list-style-type: none"> <li>21. Constructing and implementing performance assessments</li> <li>22. Methods of providing honest, informed, and constructive criticism of thinking and argumentation</li> <li>23. Identifying acceptable performance criteria or rubrics and remaining open to accepting student criteria they had not thought of originally</li> <li>24. Various methods and means for demonstrating the acquisition of relevant skills and knowledge</li> <li>25. Maintaining an overall assessment system that includes a balanced set of components (i.e., small-group and individualized; authentic and externally imposed; benchmark and routing; formal and informal; product and process; portfolios and skills demonstrations; embedded in instruction and tacked on)</li> <li>26. Understanding the concept of systemic validity (cf. Frederiksen &amp; Collins, 1989) which recognizes that the evaluation process signals to teachers and students what kinds of teaching and learning activities they are expected to carry out</li> <li>27. Methods of teacher directed- and student self-assessment for identification of entry level skills and knowledge</li> <li>28. Development of questioning strategies to elicit student's rationale and evidence</li> <li>29. Inferring understanding from students' *talk* about what they know and did</li> <li>30. Observing and understanding what students do and say while working in the environment</li> <li>31. Use of tools for portfolio maintenance that document the learning</li> </ol>

<u>Thread</u>	<u>Training Element</u>
<u>Embedding of assessment within the learning process (continued)</u>	
	32. Use of portfolios to assess learning (e.g., significance of goals, effort, productive plans, depth of reflection)
	33. Tools that can help manage the complexity of data handling and management found in authentic assessment
<u>Creation and facilitation of problem-based learning</u>	
	34. Creating problem solving learning environments that require students to set goals and knowledge development strategies
	35. Modeling and coaching support as they design and implement problems for the classroom
	36. Use of content domains in the broad societal context of super-systems (e.g., social systems, social issues) as the stimulus for learning not just knowledge of narrow content domains
	37. Creating learning environments that allow students to compare individual problem solution strategies
	38. Creating learning environments that offer real world learning experiences that students are asked to interpret
	39. Receives analytical skill development (i.e., learning to break a complex situation into component parts, identify essential and non-essential elements of the problem solving situation)
	40. Shaping the size of real world problems to adapt the issues involved to a level appropriate for student's capabilities
	41. Skills and techniques necessary to develop a situation that requires students to create and manage a project that deals with the topic/subject at hand (e.g., civics class: run an election campaign -- or have them run for office)
<u>Multiple approaches to knowledge development</u>	
	42. Multiple approaches to knowledge construction and interpretation
	43. Many ways understanding can be acquired
	44. Understanding, from an instructional design perspective, the inculcating of fantasy, curiosity, challenge, beauty, and social recognition into learning experiences (cf., the research by Malone and Lepper on motivation in technology-based learning environments)
	45. Modeling for students how one arrives at collective criteria for judging the worth of various ideas and approaches
	46. Strategies for processing ongoing discourse to raise other ways ideas might be conceptualized
	47. Understanding and use of ideas from situated cognition
	48. Understanding and application of Vygotskian principles

## APPENDIX E

### DELPHI STUDY PANEL MEMBERS

DELPHI STUDY PANEL MEMBERS

Dr. Christopher Dede

Dr. Marcy Driscoll

Dr. Thomas Duffy

Dr. Atsusi Hirumi

Dr. Michael Hannafin

Dr. David Lebow

Dr. Gordon Rowland

Dr. Thomas Reeves

Dr. Sharon Smaldino

Dr. Rex Thomas

Dr. Ellen Wagner

Dr. Jerry Willis

Dr. Brent Wilson

IMPLEMENTING CONSTRUCTIVIST-BASED DISTANCE EDUCATION:  
MORE THAN A WORKSHOP

An article to be submitted to the Journal of Staff Development

Mary Herring

School District #627: Class Community Planning 101

Mrs. Gould: Hello, all. I hope you are progressing on your plans for our new city. I looked over your project updates last night and I am pleased with what you have accomplished so far. I have a few questions for some of you.

Bob in Fargo, when you finish researching the topography of the land at the Indiana University's Virtual Library, please prepare a report and attach it to your memo to the planning committee.

Bob: Right! I have found some interesting information and have downloaded some maps that I think will be helpful.

Mrs. Gould: Ron and Ryan in Moline, what time are you scheduled to talk to the architect in Minneapolis who specializes in interconnectivity of buildings and sites?

Ron: It will be at 2:00 tomorrow.

Mrs. Gould: Does anyone else need to be a part of the discussion?

Shelly: This is Shelly in Fargo. Jordan and I need to ask some questions about the WAN mapping process.

Ron: OK, we will be in the classroom MUSE at 2:00 tomorrow, Shelly.

Mrs. Gould: When will the virtual representation of the city hall be ready for the class to view? I am looking forward to sitting behind the Mayor's desk!

This fictitious scenario offers a view of potential future distance education learning environments. These environments are supported and shaped by new views of the teaching/learning process and new media such as the World Wide Web and virtual reality. They

are also environments which are empowered by emerging media, messages, and experiences that “make possible a transformation of conventional distance education” (Dede, 1996, p. 25).

New visions about learning, the emergence of high-performance computing and communication technology, and connectivity to the information superhighway are offering educators the opportunity to rethink and restructure the way they go about designing distance education. The introduction of new technologies and means of interconnectivity have assisted educators in beginning a change from traditional, delivery methods of teaching towards more student-centered and resource-based approaches to instruction (Jonassen, Davidson, Collins, Campbell, & Haag, 1995). In a discussion of educational change, a body of learning theory, constructivism, and its role in distance education is being addressed (Jonassen, Davidson, Collins, Campbell, & Bannan Haag, 1995).

Constructivism is a relatively new body of theory about knowledge and learning that recognizes the effect an individuals’ prior knowledge and perceptions have on the creation of new knowledge (Knuth & Cunningham, 1993). Constructivists believe that knowledge is a function of how the individual creates personal meaning from his or her experiences: knowledge is not seen as the result of what another says is true (Jonassen et al., 1995).

The term “distance education” refers to teaching and learning situations in which all or some of the students and instructors are geographically separated and, therefore, rely on electronic devices and other support material for creation of the learning environment (Portway & Lane, 1994). Classrooms can now be extended through the use of telecommunication technology. Access to basic telecommunication technology (e.g., computers, modems, and phone lines) as well as more advanced forms of technology (e.g. fiber optic and teleconferencing systems) have been suggested as essential components of the educational change agenda (Means et al., 1993; Papert, 1992) and show great promise for distance education settings.



The combination of constructivism and distance education, as in other change efforts, requires teachers to reexamine their teaching practices as well as their beliefs or understandings about curriculum and learning (Fullan, 1991). The combination creates a picture of deep rather than superficial change from what many teachers now do in their classrooms. Past attempts at change have focused on product development, legislation, and other on-paper changes in a way that ignored the fact that “what people did and did not do was the crucial variable” (Fullan, 1991, p. 65). In a change effort, it is important that those charged with implementation realize that educational change is a learning experience for both adults as well as students.

According to Fullan (1991), successful change efforts must address key factors necessary for implementation. In this article a process of identifying one of those factors, teachers’ knowledge base, will be presented. Descriptions of the creation of constructivist-based learning environments (Wilson, 1996) and of distance education (Willis, 1994) exist, as do studies of teachers’ roles in distance education (Thach & Murphy, 1995), but there is little published research on the knowledge needed by teachers to create, facilitate, and assess constructivist-based distance education.

Through the use of the Delphi technique, a consensus building research strategy, a panel of nationally recognized individuals in the areas of constructivism and technologically mediated education identified what it is that teachers need to know to create, facilitate, and assess constructivist-based distance learning environments. This article will describe five design-guiding principles and the knowledge identified as needed by K-12 teachers to implement their use. Based on the researcher’s experience as a distance education staff developer and the findings from the Delphi study, suggestions will be offered for staff development that support teachers as they design and implement learning environments at a distance. The results show that teachers need extensive and ongoing staff development if change is to take place. Attendance at a workshop is not sufficient to implement this complex web of change.

## The District #627 Teacher Support Project

### Project Context and Design

Because constructivists believe that learning should be situated in an authentic context (Honebein, 1996), this project was situated in the simulated environment, School District #627, which is totally based on distance education. The entire School District #627 project was carried out using email for basic communication and the World Wide Web for the Delphi study. Fifteen panel members were informed that the fictitious district had chosen constructivism as the foundation for learning. To support the learning, a knowledge base for teachers was needed for the planning of staff development. During the four phases of the Delphi study, five design-guiding principles were developed. Panel members were asked to provide not only one example of a learning environment design component or experience that would exemplify each principle, but also the essential elements of teacher preparation needed by District # 627 teachers to implement the design or experience. Analysis of the very thorough responses resulted in 21 design components or experiences and 70 essential teacher preparation elements. Panelists then rated each component, experience, and element as to its importance with relation to the design of constructivist-based distance education. They also had the opportunity to comment on responses to each item.

### Data Collection and Analysis

Panelists' comments provided a running dialogue throughout the Delphi study. At the completion of the Delphi study, 17 components or experiences and 46 teacher training elements were found to be important or very important by the majority of panel members after the final two iterations of the Delphi study. Thirteen panelists completed all phases of the year-long project. The responses were statistically analyzed by the Delphi Statistical Tool [DST] (Holden, 1992). The DST computed the mean, median, interquartile range (consensus zone) and quartile deviation. Findings presented in this article address teacher training elements on which the

panelists were at moderate or high consensus and which were rated as being important or very important.

### Results and Suggestions

The following is a discussion of the findings from the School District #627 Instructional Support Project about the implementation of five design-guiding principles by K-12 distance educators. Each discussion is followed by suggestions for staff developers involved in supporting the implementation of constructivist-based distance education.

#### Principle One

Provide learning experiences which promote student reflexivity about both the content learned and the learning process in order to develop student's self-awareness of the constructedness of knowledge and student's self-control over the learning process.

The first design-guiding principle's issues addressed the concept of knowing how we know (i.e., reflexivity). Knuth and Cunningham (1993) define reflexivity as an awareness of the constructedness of knowledge and the active control over that construction process. Panelists indicated that staff development activities that promote reflexivity should include the development of problem-based learning environments situated in contexts that students could identify as authentic, whether "authentic" is an out of school context or an academic activity where they generate knowledge.

Of particular importance to panelists was the teachers' ability to create learning environments that offered students opportunities to chose paths in solving problems within an authentic context. To facilitate that process, teachers need training on how to assist students in the knowledge construction process. This training should include methods that incorporate student goal setting, use of knowledge development strategies, and methods of documenting learning (e.g., concept maps, journals, web sites). Teacher training should also include multiple strategies for knowledge construction and interpretation. Finally, teachers need to know how to use tools that allow the distance classroom participants to compare their views to

others, reflect on their knowledge construction and then modify according to those comparisons and reflections.

Suggestions: Teachers who have been traditionally trained as dispensers of knowledge will need broad-based support to implement this principle. Responses in this area showed that students are to be given much greater latitude in choosing paths of knowledge construction. When the teacher no longer has the “one right answer” the dynamics of the classroom are radically changed. The staff developer will need to spend considerable time working with the teachers to understand and accept the shift in control of the learning process. Teachers will need reassurance that goals will still be set and that a wide variety of methods, including both existing practices and new strategies, will need to be understood in order to respond to the varying needs of students. Software applications such as Inspiration (1994), a concept mapping software application, can assist in demonstrating paths of knowledge construction.

Staff development should model constructivist beliefs, experiences, and tools needed for the learning process. Teachers need to experience the same “real world” situations as their students. A stand and deliver method of training will not offer the type of modeling teachers need to experience. Active participation in the teachers’ knowledge construction is equally as important as is the students’. To deal with the complexity of these learning situations, an ongoing structure of support within and between education entities should be developed and built into the teachers’ professional lives. Joyce and Showers (1996) offered support for this concept suggesting that the building blocks of a staff development system are coaching teams and study groups. Peer coaching teams serve as support for individuals as they seek to improve their clinical skills or academic knowledge. Peer coaching occurs in the school after initial training with teachers forming small (2 to 3 teachers ) groups. It has several purposes: (a) to build communities of teachers who continuously engage in the study of their craft; (b) to develop shared language and common understandings necessary for the collegial study of new knowledge and skills; and (c) to provide a structure for the follow-up training that is essential

for acquiring new teaching skills and strategies. Coaching teams link together into study groups (4 to 6 teachers) which meet to support one another through mutual study and problem solving as they work on implementing district-wide initiatives in curriculum, instruction, and technology. All three initiatives require “extensive study and training” for successful implementation (Joyce & Showers, p. 3).

### Principle 2

Create dynamic, challenging, learning environments which are appropriate for the student’s level of expertise, development, and culture and encourage, facilitate, and support students taking ownership of the learning process.

Principle Two addressed the novice-to-expert learning continuum and its impact on the student’s ownership of the learning process. The teacher training element with the highest consensus and the highest rating in the Delphi study was identified under this principle: Teachers serving as a guide/facilitator for students rather than as an expert. Teachers need to be able to model and provide coaching support for each student as he or she carries out varied research strategies. They also need to assist students in the realization that they can develop and carry out their own learning strategies. Again, the issue of understanding multiple ways of approaching learning was found to be important.

Suggestions: A key to the design of these learning environments is the shift in the role of teacher. Not only do teachers need training in what it means to facilitate learning, but they also need training on how to acclimate their students to the changed learning environment. The staff developer should create situations in which the participants must work both individually and in group settings on problems presented via a telecommunication network. It is important to the learning process that the teachers are placed in situations much like their students so they experience the modeling and coaching strategies needed to support their students. The acknowledgment that students need training to function in a new learning environment is an important component of this principle. If students have not previously been involved in this

type of learning they, just like the teacher, will need support before and during the learning process. Both teacher and student will also need to learn the use of tools that allow monitoring of the learning process such as e-mail, list-servs, and collaboratory environments on the World Wide Web.

### Principle Three

Given a relatively defined domain of knowledge and learning goals, design authentic instruction situations that have relevance or, through teacher mediation, can become relevant to students and that actively engage students in the construction of transferable meaning.

Principle Three dealt with the creation of the authentic learning environment. To be authentic, a learning environment's "cognitive demands, i.e., the thinking required, are consistent with the cognitive demands in the environment for which we prepare the learner" (Savery & Duffy, 1996, p. 135).

Relevancy of the learning was a key to teacher training for this principles' implementation. Attention to issues and projects that motivate students, such as fantasy, curiosity, challenge, beauty, and social recognition, were given top priority. Panelists recognized that the environment must be inherently motivating to the student in order to be successful. The use of a broad societal context rather than narrow content domains was seen as assisting in making the issues relevant by grounding them in authentic instructional situations. Again, the training of students was found to be important to their ability to function in situations in which they are required to direct and manage a project reflective of the topic at hand.

Suggestions: The use of "broad societal contexts" brings to mind the concept of interdisciplinary teaching. Teachers not only need to learn the theoretical foundation of this type of teaching, but also the generic skills and methods for implementation. To facilitate students, teachers will need access to more than their chosen domain of expertise. The use of electronic means of connectivity can provide teachers with not only alternative resources for themselves

but also for their students. With the broad-based access to information and resources that telecommunication networks provide, teachers no longer need to be the singular experts in the classroom. Webs of expertise can be created both by the teacher and by the students. Planning and accessing strategies for relevant resources use such as the WWW Yellow Pages and various WWW search engines can support the development of information webs. Strategies for planning and finding appropriate resources can also save great time and energy for both teachers and for students (see e.g., Pappas, 1995).

#### Principle Four

Develop learning experiences which encourage the social negotiation of knowledge and provide learners with the opportunity to evaluate individual understandings of concepts and to expand individual and shared understandings.

Principle Four focused on the use of collaboration and interaction in inquiry learning and the social negotiation of knowledge of the learning process. The topics contained in this principle are pivotal to the design and implementation of constructivist-based distance learning environments. Collaboration and interaction are not only a key to constructivism but also, due to the expanding capabilities of new technologies and networks, to distance education.

Panelists noted that in order to facilitate the transformation of typical classrooms into learning communities, teachers need to understand the use of questioning strategies to elicit, not direct, students' rationales and evidence of learning. Teachers also need to learn and demonstrate strategies for processing the ongoing dialogue, so students learn to hear, analyze, and evaluate others' ways of conceptualizing ideas. Panelists brought up the need for embedding problem solving in a social framework as it relates to the implementation of this principle. The intent of this embedding was to expose the students to multiple perspectives and a spectrum of individual problem solving skills. Interestingly, the discussion among the panelists turned to a need for students to learn skills of negotiation, conflict resolution, and mediation. These skills were identified as necessary in developing communities of learners

where each individual risks expressing and defending ideas without feeling threatened, thus allowing the community to compare and contrast varying perspectives on the issue at hand. In the distance setting, the teacher will also need to design "learning communities" that require students at different sites to work with one another and to use tools that allow students to post and provide feedback to one another.

Suggestions: The staff developer will definitely need to focus on strategies for creating and facilitating self-directed and collaborative learning within the distance classroom. Since the students are not all located in the same setting, the development of these environments will need extensive examination. Teachers have expressed concern that collaborative learning will not be equitable learning by all students. Training and experience can help teachers to anticipate some of these problems. A ongoing electronic "network of discourse" between teachers, either within a district or from around the world, involved in creating constructivist-based distance education can help to reduce these problems. There is widespread information available on the use of cooperative learning which can be explored, but adaptations for the distance setting such as methods of structuring communications and collaboration between sites are needed. The specifics of these methods will depend on the configuration of the telecommunication networks being used to connect the distance class. Teachers' comfort level with students sharing ideas through discussion or electronic postings during the learning process and the use of the appropriate software and hardware tools to support these actions should also be addressed in the training. Skills and strategies for supporting the use of "real world" contexts such as negotiation, conflict resolution, and mediation will all need to be considered. Learning how to monitor and question the learning process without students feeling threatened is also important not only for teachers but also for student interactions.

#### Principle Five.

Use dynamic, authentic assessment that is embedded in the instructional process to assess both student learning and the learning environment.



Principle five addressed the integration of assessment into the learning process. It incorporated the negotiation of performance criteria or rubrics between the teacher and the student. Of primary importance to this process, and receiving the second highest rating from the panel, was the ability to construct and implement performance assessments. Performance assessment is dynamic assessment that occurs during instruction rather than after the fact. Its purpose is to measure student's assisted performance during the learning process so teachers can address problems, issues, and concerns as they occur. It helps to identify what "students are learning now and anticipates what the students will be able to do in the future" (Dixon-Krauss, 1996, p. 127). Although performance assessment was seen by the respondents as important, a concern about the amount of time it takes and the need for a balanced, rather than singular, set of evaluation components was clearly indicated. Also identified was the need to embed the assessment in the learning process rather than have it as a separate component.

According to the findings of the Delphi study, it will be important for teachers to have knowledge of and access to programs that will support learning assessment. A method of performance assessment that can be dynamic in nature, and embeds the assessment in the learning process, is the use of portfolios. Portfolios consist of multiple sources of evidence of a student's learning selected, collected, reflected on, and discussed over time with fellow students and teachers (Dixon-Krauss). The use of tools for portfolio maintenance was considered very important because it was one of the few relatively well developed ways of assessing that could be integrated into the learning process.

The Delphi study identified that teachers will need training to use assessment as a means to mentoring, guiding, and evaluating students as the students increasingly become responsible for learning. In doing so, students will become mindful in their exploration of errors and can learn to give thoughtful consideration to their and others' knowledge-construction process while teachers facilitate the process by regularly assessing the status of the learning.

Suggestions: The role of assessment in constructivist-based distance learning environments is complex. The assessment should evaluate the effectiveness of multiple approaches to meeting the learning goals both individually and collectively. The procedures and standards for assessment should be brought into the learning discussion with both teacher and students providing input. Just as there will be many ways of approaching the learning tasks so, too, will there be equally as many ways of demonstrating the learning. Teachers will need time to develop an understanding of what alternative assessments look like in order to facilitate this process. An example identified by the panelists was portfolio assessment.

There are a growing number of electronic tools that can facilitate the creation and assessment of portfolios. Computer programs such as Grady Profile (Aurbach & Associates, 1993) and Hyperstudio (Roger Wagner Publishing, Inc., 1996) are being used to assemble, track, and assess the volume of information and artifacts that can represent the learning process. Authentic assessment simulations, incorporated during staff development, will provide models and richer understandings for teachers.

Addressing this principle, one panel member offered that "many participants, new to 'student-centered learning environments,' must go through a transformation in attitude on their way to accepting increased responsibility for their own learning." This applies not only to assessment, but to the implementation of all five principles. Attitude is a key to the focus of the staff development. Attention must be paid to the teacher's attitude and knowledge about the learning environment.

#### Discussion and Conclusions

A discussion of change and its impact on teachers and staff development is important if the findings from the Delphi study are to be incorporated into the professional training of teachers. The discussion begins by first addressing staff development design issues followed by general conclusions about incorporation of the School District #627 findings into the training.

### Staff Development Design

The findings from this study show the complexity of change for teachers beginning to design constructivist-based distance education environments. A supporting staff development program should not be a "one shot" workshop. The volume of knowledge needed to create these environments is too great to be handled lightly. Joyce and Showers (1988) stated that present staff development is often too weak to support curriculum change of the magnitude new approaches to learning and new technology offer; therefore, placing teachers in environments with these learning opportunities can be very threatening. For successful implementation, teachers must be comfortable with constructivist-based learning and its requirements, and they must be proficient at using the technological innovations and opportunities so they can facilitate their students' use of it. Unfortunately, school districts have all too often adopted a version of the Field of Dreams motto, "If we buy it, they will use it as we intend." Administrators often expect that the placement of teachers, students, and technology in the same setting will lead to technology becoming an integral part of a transformed teaching and learning process. This dream of technology driving educational change has continually failed in transforming teaching practices (Cuban, 1996).

It has been suggested that general knowledge about staff development strategies and change management is necessary, but perhaps not sufficient, for creating and supporting effective assistance to teachers implementing specific complex innovations (Anderson, Rolheiser, & Bennett, 1995). Asking teachers to change the way knowledge is constructed in their classrooms and to change the configuration of their classroom is a difficult task. A sophisticated array of diagnoses, philosophical understandings, teaching strategies, activities, and organizational structure are required if effective implementation is to be achieved (Fullan, 1991). This process can be facilitated through the use of instruments developed to assist change strategies such as the Concerns Based Adoption Model (CBAM). CBAM builds into the change process, through the use of a stages of concern questionnaire, consideration of

teachers' concerns as a basis for facilitating and personalizing staff development (Hord, Rutherford, Huling-Austin, & Hall, 1987). Research has shown that attitude will have the greatest effect on teachers' adoption of the use of distance education (Abou-Dagga & Herring, 1994). Concerns or attitudes that users, or potential users, have about an innovation such as constructivist-based distance education will certainly impact the type of training needed. A wide number of issues were elicited during the Delphi study, and it is up to the staff developers to determine which will be appropriate for their audience. Assessment of teachers' attitudes or concerns, such as is offered in the CBAM model, will help staff developers use what participants already believe and know in the generation of new knowledge, thereby modeling a constructivist approach to staff development as well as reducing complexity by targeting the staff development to the specific needs of the participants.

### Project Findings

The previously addressed training threads that consistently were identified as important or very important to the training of teachers in order to enable the design of constructivist-based distance learning environments included:

- Learning guide or facilitator roles for teachers
- Training needs of students to carry out learning strategies
- Embedding of assessment within the learning process
- Creation and facilitation of problem-based learning
- Multiple approaches to knowledge development

It is strongly suggested that strategies for these five items be incorporated into ongoing staff development.

Perhaps the most surprising outcome of this investigation was the secondary role of technological tools in the process. Many distance education training sessions have centered around operational issues such as time management, classroom management, instructor

presence and presentation. These results show that training should first center on learning issues that deal with the development and implementation of the curriculum followed by discussions of operational issues and use of technology.

Many have spent great time and effort discussing constructivism and its translation into the classroom. Products have been created to develop constructivist-based learning environments. Technology has opened a Pandora's Box offering countless opportunities for reconfiguring what we do in classrooms. Caught in the middle of all this are teachers who are expected to design environments that incorporate these new theories and methods of learning. Whatever the level of the participants, attention to the learning process, both for the teachers and for the students, should be central to the training and should be an ongoing process, embedded in the teacher's professional life. In other words, a comprehensive plan of staff development is needed: in other words, more than a workshop.

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## GENERAL CONCLUSIONS

### Reflections

The key issues in this research were addressed through the use of the Delphi consensus building technique and the results were presented in several formats. The first paper contained a review of societal changes impacting education and the use of constructivism to create and implement distance education learning environments. The research methodology of the second paper used a cadre of nationally recognized panelists to develop an instrument containing design components or experiences and the teacher training elements necessary for their use to implement five design-guiding principles for constructivist-based distance education. The results of this process showed that 90% of the items fell into the moderate to high consensus zone, verifying that the panel was consistent in their thinking about the items. Eighty-one percent of the items reached moderate to high consensus with an important or very important rating demonstrating the strength of the study's results. This was a very complex study that included 95 items, four phases, and a one year time frame.

Several training threads were woven throughout the fabric of the findings:

- Learning guide or facilitator roles for teachers
- Training needs of students to carry out learning strategies
- Embedding of assessment within the learning process
- Creation and facilitation of problem-based learning
- Multiple approaches to knowledge development

Specific teacher training elements for these areas can be found in the tables of the article. The most surprising outcome of this investigation was the identified secondary role of technological tools. Many distance education training sessions have centered around issues such as time management, classroom management, instructor presence, and presentation concerns



(i.e., operational issues) and the impact of the technology upon them. The results showed that the training should first focus on the development and implementation of the learning environment (i.e., instructional issues), then focus on the operational issues to be addressed.

The third paper focused on support for staff development activities. It was structured around five design-guiding principles for constructivist-based distance education and the knowledge base needed by teachers for their implementation. Staff developers were warned that the volume and contents of the results clearly showed that a staff development program, based on the findings, would need to be an on-going process embedded in the professional lives of the teachers. Staff developers were strongly encouraged to incorporate a constructivist base as they plan their activities, so that teachers not only learn to “talk the talk” but also to “walk the walk.” The Concerns Based Adoption Model was shown to support changes found in the needs of the researcher’s own experiences with staff development.

Constructivists believe that a prior knowledge will impact knowledge construction, so staff developers are strongly encouraged to assess their participants and tailor their plans to meet the needs of individuals. Because individual needs should drive the staff development plan, a step-by-step staff development procedure was not presented. Instead, the results were presented as a body of knowledge. Their use will be dependent upon the context and experience of those charged with the design and implementation of constructivist-based learning.

### The Next Step

Many districts have responded to school reform with a shot-gun approach to staff development, offering teachers a cafeteria plan. In the plan, teachers select what interests them most rather than participate in a process that will provide them with knowledge that supports district-wide initiatives. This leads to a fracturing of the teaching/learning process and often leaves teachers as well as students trying to “figure out” their role in the classroom. The findings from this study can result in the first step in a mission to support teachers as they are

impacted by calls for change and restructuring. Districts need to develop overall goals for the district and then offer staff development that not only addresses the issues but also provides the time, mentoring, and support for teachers to truly change how they go about the teaching and learning process. Innovations can not be sustained if there is not a shared understanding of their purpose, rationale, and processes (Fullan, 1991).

The next step is to take these findings and apply them to a staff development process. The findings have provided the researcher with a wealth of information and a much more insightful view of the what is needed to successfully integrate constructivist-based teaching with technology. Those planning for the integration of technology into an educational system need to closely examine the findings and develop activities based on the type of learning they want in the classroom, rather than the type of technology.

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